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24 December 1984

China Report

ECONOMIC AFFAIRS

ENERGY: STATUS AND DEVELOPMENT -- 34

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CHINA REPORT

ECONOMIC AFFAIRS

ENERGY: STATUS AND DEVELOPMENT -- 34

CONTENTS

THERMAL POWER

COAL

OIL AND GAS

NATIONAL POLICY

MEETING STRESSES INCREASED COAL DELIVERIES TO POWER CONSUMERS

Current Shipments Falling Short of Demand

OW061303 Beijing XINHUA Domestic Service in Chinese 1531 GMT 5 Dec 84

[Text] Beijing, 5 Dec (XINHUA)--The national telephone conference of coal mines, conducted on 5 December from Beijing, proposed that coal mines closely coordinate with transport departments to accelerate coal shipments to ensure coal supply to the four major power supply networks in the Beijing-Tianjin-Tangshan, Northeastern China, Eastern China, and Central China areas.

Due to the enforcement of reform, which resulted in "integration" of coal production, distribution, and shipments, the delivery rate of coal to power plants in the first half of this year was close to 98 percent and a coal supply of 1.35 million tons above plan was registered, basically guaranteeing coal supply for electricity generation. However, since the beginning of the fourth quarter, some problems arose in coal shipments and some power plants had to cut down their electricity generation due to coal shortage, thereby aggravating the shortage of electricity supply in some areas.

Greatly concerned over this situation, leading comrades of the State Council ordered departments concerned to quickly take firm and effective measures to guarantee the planned supply of coal to power plants. Based on this order, the telephone conference on the evening of 5 December proposed the following five measures: 1) All coal mines must fulfill their respective coal shipment plans. First of all, they must ensure the fulfillment of coal supply plans for the four major power networks. 2) They must coordinate with railway departments to ensure coal shipments. Those coal mines which have completed this year's state plan must keep the overall situation in mind, keep increasing their production, and ship more coal. 3) Coal mines which have not yet fulfilled this year's state plans for coal shipments should not market the coal produced above quota. 4) All coal mines must deliver coal to customers strictly according to contract stipulations and give priority to ensuring the supply of coal to the four major power networks. 5) They must improve the management of coal shipments and keep a close watch over the coal shipment situation. They must report daily to the Ministry of Coal Industry on the quantities of coal they have shipped to the four major power networks.

Lack of Railway Rolling Stock Partly to Blame

OW062327 Beijing XINHUA Domestic Service in Chinese 1151 GMT 6 Dec 84

[By reporter Huang Fengchu]

[Excerpt] Beijing, 6 Dec (XINHUA)--The reporter has learned the following information from the Ministry of Railways: On 4 and 5 December, the railway transport department moved 540,000 metric tons of coal, 130,000 metric tons more than originally planned, for four major electric power grids--the Beijing-Tianjin-Tangshan, the Northeast, the East China and the Central China power grids. It has begun to improve the supply of coal for power generation use, a situation existing since the beginning of the fourth quarter.

It is reported that the coal for power generation use, transported by the railways in October and November, was some 830,000 metric tons less than planned, due to insufficient rolling stock and loading restrictions, causing a drastic drop in coal stocks in electric power plants, forcing some of them to reduce power generation, and affecting industrial production and the people's livelihood.

The leading comrades of the State Council attached great importance to the situation, instructing the departments concerned to adopt resolute and effective measures to ensure the coal supply to electric power plants as soon as possible. Acting on the instruction, the Ministry of Railways held a telephone conference of all railways on 3 December, and proposed several measures to ensure coal transport.

CSO: 4013/57

NEW PROSPECTS FOR AUTOMATION OF POWER NETWORK DISPATCHING OUTLINED

Nanjing DIANLI XITONG ZIDONGHUA [AUTOMATION OF ELECTRIC POWER SYSTEMS] in Chinese Vol 8, No 1, Jan 84 pp 3-9

[Excerpts] Current Status and Future Prospects of Automation of China's Power Network Dispatching

Speaker Cai Yang [5591 3152] (Chief engineer and senior engineer of the Dispatching Communications Bureau of the Ministry of Water Resources and Electric Power)

The automation of dispatching in China had a relatively early start. In 1958, the newly established automation committee in the Northeast began research in the areas of remotely operated and self-operated frequency modulation and efficient dispatching using simulators. From the 60's to the 70's, computers were introduced to perform numerical calculations. In the 70's, computers were initiated in dispatching automation and in using computers to perform safety monitoring for the three major power networks in the northern region, the eastern region, and the northeast region. During this period, a team of automation experts in the areas of research, production, operation, and maintenance was formed.

However, today the foundation of automation is still quite weak; communications and remote operation technologies are lacking in both quantity and quality. Many of the million-kW local dispatching offices have only one or two remote operation units, some of which are not even in service. Second, the accuracy and reliability of the equipment are poor and the requirements of automated dispatching cannot be fully met by Chinese-built computers. Dispatching automation involves complicated numerical calculations; the entire process of data collection, data transmission, data processing and analysis, and the transmission of computed results to the dispatching units involves tedious tasks which require compatible hardware and software, and new application software that must be developed.

Our current plan is to follow a two-phase development of dispatching automation: building a solid foundation prior to 1990, and full-scale development after 1990. By the year 2000, we hope to reach a level comparable to the standard of advanced countries during the late 1970's and early 1980's. In

certain areas we expect to reach the same level as the international standard. The task of foundation building involves the following three aspects:

1. Communications technology and remote operation technology must meet the requirements of dispatching automation. We must establish a digital microwave network centered in Beijing and microwave links connecting the network dispatching and provincial dispatching units; we must build communications and data transmission networks between the power plant and the power distribution office, the transformer station, the local, provincial and network dispatching units, and the Ministry of Water Resources and Electric Power.

2. We must import new technologies from abroad including complete systems and high-level software to satisfy the needs of the four major networks.

We must devote efforts to the research and production of dispatching automation systems. The Electric Power Research Institute and the Nanjing Institute of Automation are planning to incorporate imported equipment in two major networks to form a dispatching automation system for primary provincial dispatching in the future. Before 1990, we hope to build a dispatching automation system with high level software and capable of network, provincial, and local dispatching; after 1990, we hope to have three-stage dispatching automation systems in common use. Around the year 2000, we expect to build a nation-wide dispatching automation system linking the Ministry dispatching center with seven network dispatching units, 23 provincial dispatching units, and over 200 local dispatching units.

Automation of Power Network Dispatching Requires Unified Planning

Speaker Peng Chunshao [1756 3196 4801] (Deputy chief engineer and senior engineer of the Dispatching and Communications Bureau of the Ministry of Water Resources and Electric Power)

To achieve automation of power network dispatching, it is necessary to establish a unified plan for the 7 network dispatching units, 23 provincial dispatching units and 146 local dispatching units. During the computer application conference at the Ministry, it was agreed that dispatching planning should start from the network level, then proceed to the provincial level, and finally to the local level. Such a top-down approach is compatible with the present condition in China. There are two general approaches used by other countries: In Japan, the top-down approach--from company dispatching to local and system dispatching--is used; France on the other hand uses the bottom-up approach, starting from local dispatching. In China, there is no urgent need for achieving automation of local dispatching, but the safety and reliability of large systems are critical, hence it is logical to start planning at the network level. Currently, a planning effort is being pursued jointly by the network dispatching units and the planning and design institutes.

The planning effort must be followed by a plan of execution. First, we must insist on using the systems engineering approach. In the past, work was carried out in bits and pieces with no clear sense of direction. From now on we must take the overall system approach where we consider not only computers but

also basic engineering issues such as communications and remote operation, as well as equipment repair and maintenance. Second, we must strengthen our efforts in building a good foundation. While improvements have been made in communications equipment, a great deal of work remains to be done in the area of remote operation. In developing microcomputer-controlled remote operation, we must clearly specify the system to be used; since current remote operation equipment is mostly made in this country, we should allow a transitional period to convert from one system to another. I suggest that a working group or a committee be established to specify the basic rules, the structure, and the scope of remote operation systems. The Department of Science and Technology should also establish an organization in charge of standardization and serialization.

In closing let us discuss the idea of data networks. A power network system consists of local, provincial and network dispatching units which would be very difficult to manage without an efficient data network. In other countries, the formation of data networks is a step-by-step process: first, isolated networks are constructed, then they are linked to computers, and finally an integrated data network is formed. This process involves technologies of computers, communications, and remote operation. Based on China's current situation, it is probably more logical to follow a two-step process. First, we concentrate on developing a dispatching data network whose primary function is to exchange data rather than sharing resources. The second step involves managing the data network; initially we will share the public data network, eventually, a dedicated data network will be developed. This approach is feasible for power systems because most of the plans, materials, and resources of power systems are distributed among the major power networks and therefore are suitable for unified management.

New Problems of Remote Operation Should Receive Special Attention

Speaker Xu Wenqin [6079 2429 7230] (Engineer, Department of Technology, Ministry of Water Resources and Electric Power)

To fully utilize electric power, it is necessary to establish a unified command. Because of the high concentration of electric power networks, the safety and reliability requirements are highly critical. Today, computer-controlled network dispatching automation systems are being widely implemented abroad. In China, computers were first used for safety monitoring of the three major networks, but progress in computer usage was very slow. Now that we have decided to import complete systems from abroad to be implemented in the four major networks, we must establish clearly defined dispatching policies and begin to construct the necessary buildings for dispatching units. We must ensure that the imported equipment is compatible with domestic communications and remote operation requirements. For base dispatching, we should consider the automation of frequency modulation and thermal engineering. We should develop a computer-controlled power network dispatching automation system that includes main frame, pre-processor, display units, and remote terminals. Such a system must have compatible hardware equipment, compatible hardware and software, and compatible interface between software units. This is a technically challenging task that requires a high degree of coordination.

Let me say a few more words about remote operation. Remote operation is an old technology that is undergoing a major evolution for solving new problems. For example, the old contact-type remote operation units have evolved into the non-contact type; also, the new remote operation units are equipped with microprocessors to provide intelligent functions to serve the power plants. In addition, we are faced with a decision to select the type of system for remote operation in this country. In the past, China's remote operation units were mostly based on the cyclic system; however, imported remote operation units mostly use the inquiry and answer system. It is expected that these two systems will initially coexist; during this period, we should try to arrive at a decision by objectively evaluating the merits of each system. Furthermore, we should encourage active discussions on such problems as transmitting data between remote operation units, establishing a real-time information exchange network, and developing a method of interface with the data communications network. Hopefully these discussions will lead to a decision on a unified approach. With the automation of power network dispatching, new requirements are also imposed on the remote operation channels; e.g., higher speed of communication and automatic switching of standby channels.

In short, remote operation technology is now faced with a new challenge. In order to meet this challenge and to accomplish the multi-terminal mission, comrades in research and development must work closely with comrades in production, design, and manufacturing and contribute their best efforts toward the realization of automation.

The Rewarding Task Facing Automation Workers

Liu Jue [0491 6030] (Chief engineer and senior engineer, Systems Office, Nanjing Automation Research Institute, Ministry of Water Resources and Electric Power)

Recently, an event of historical importance took place for the automation of power network dispatching when it was designated as a key target for national computer application. This also illustrates the fact that with the development of China's four modernizations program and the continuing growth of the power networks, automation is no longer a luxury, but a necessity to ensure safe and efficient operation of power networks. In addition, this event also reflects the accomplishments in automation by various electric power departments in recent years despite rather difficult conditions.

According to the current plan, by the year 2000, all dispatching units at the network level, provincial level, and local level will have implemented various degrees of automation; this is a monumental task. In order to accelerate the pace of development, improve quality, and establish certain benchmarks, it is appropriate to import a number of systems from abroad at the present time. By working with the imported systems we can gain some experience on how to operate these large integrated automation systems, understand the key technologies, and develop our own technical capabilities, so that we carry out similar tasks and develop systems that meet China's needs. This should be our major goal. We have accumulated almost 10 years of experience in research, development, and operation of our own systems; we have established a good technical

foundation and our achievements in network control theory compares favorably with those of other nations. Our main problems have been the lack of experience in carrying out large projects and our low standard in manufacturing technology. These are the areas where we should concentrate our learning efforts.

The automation of power network dispatching is an integrated effort which involves research, engineering, production, and maintenance and requires both hardware and software development. To accomplish this challenging task we must have an overall plan; we can no longer delegate the responsibilities to the individual organizations and let them solve their own problems. Therefore, there is a need to select a research organization with mature conditions and technical strength to set up a center dedicated to the development of automation systems of power network dispatching. This center will be able to undertake projects of system automation for various power network dispatching units; it can take on the responsibilities of system design, interface design, equipment selection, hardware coordination, and software development. It can award contracts to special factories to produce the hardware and peripheral equipment according to its specifications; the contracted organizations will be responsible for the overall system compliance, performance, quality, and schedule of the project. In this manner, the development center not only serves as a study organization, but is intimately involved with the project; furthermore, it may also assume direct responsibility for certain project tasks. As a consequence, it must be managed differently from a pure research organization, and must address problems of coordinating with organizations.

Over the years, the Nanjing Automation Research Institute has made a number of contributions in the area of dispatching automation, but it is still far from being able to meet future requirements. We have taken the first step toward contracting domestic projects of dispatching automation by organizing special offices of the Institute to undertake larger projects; we hope to obtain some results within a year or two. Our future task is to combine the different requirements of China's power network dispatching units at various levels and establish China's own serialized and standardized dispatching automation system. We will also cooperate with factories to develop a capability of mass production and parts supply. Working side by side with our sister organizations, we shall strive to reach our goal by the year 2000.

How To Create A New Scenario For Power Network Dispatching

Wang Mingjun [3769 2492 0193] (Deputy director and senior engineer, Office of Computing, Electric Power Research Institute, Ministry of Water Resources and Electric Power)

In 1960, this Ministry established a plan of using computers in power network dispatching automation system. It has been 15 years since the first on-line computer was installed in the Beijing-Tianjin-Tangshan power network in 1968. During these 15 years, we have had significant accomplishments, accumulated valuable experience, and developed a team of trained personnel; we have also established a favorable reputation at international conferences. But compared with developed nations, we are still lacking in quantity and quality, and our

basic technologies in automation, e.g., communications channels and remote operations, are very weak. During the early years, because of the weak foundation and inadequate support in communication channels and remote operations, the implementation of computers produced essentially no improvement in system performance. For example, the functions most favored by operators such as event sequence recording and channel monitoring/automatic switching could not be achieved using the most powerful computer without the support of microprocessor remote operations. Of course, converters and communication channels also have a major effect on the accuracy and speed of data transmission. Therefore, we must create a new scenario by using system engineering techniques to develop a practical system where remote operation (including converters), communication channels and computers all perform their respective functions. Through industrial tests and development, we will eventually be able to apply such systems to solve the problems which now exist in China's power network dispatching.

Let us discuss how we can create such a scenario.

(1) We must have a centralized direction and unified planning. In the past, there had been too many computer types with no unified direction and planning, and no unified specifications and standards. Since the computer guidance group was formed at the Ministry, authorization was given to the Dispatching and Communications Bureau of the Ministry to be responsible for all dispatching automation work and for specifying the computer type. This is the first step toward creating a new scenario.

(2) We must clearly identify our goal. In general, there are three levels of dispatching automation systems: the safety monitoring (referred to abroad as the SCADA) system, the energy control (referred to abroad as the SCADA+AGC/EDC) system, and the energy management (referred to abroad as the EMS) system. In foreign countries, the basic SCADA system is now quite common; most large power networks are equipped with mid-level systems but there are few high-level systems. Making a decision on the level of automation system will have an impact not only on the selection of automation equipment but also on the development of future power networks. Based on China's current automation standard and its current status in power network development, we can predict that by the 1990's it is entirely possible to have widely distributed SCADA systems, SCADA+AGC/EDC systems for most inter-provincial networks and a limited number of provincial networks, and achieve the EMS level for two or three inter-provincial networks.

(3) We must have a policy which centers around application and devote our efforts to basic automation technology and to the development of application systems. The traditional policy of centering around a main computer must be replaced. Computers are different from other electronic products. For example, radars and satellite ground stations can be put into service once they are tested and certified. But a computer must undergo a 2-stage development process before its utility can be fully realized. Although we are an application organization, we still face the decision of whether to center around a main computer or around application. For a power network dispatching automation system which centers around application, efforts should be

dedicated to basic automation technologies such as converters, remote operation channels, and to the development of a complete application system with compatible hardware and software.

(4) We must pay attention to economic benefits. A computer can only generate economic benefits through application. But the degree of economic benefits depends on how it is used. To fully achieve the economic benefits of dispatching automation systems, we must select a computer whose capacity and performance are compatible with the standard of development of the power network; we must ensure that automation systems are implemented station by station and channel by channel.

(5) We must take advantage of the open-door policy and use imported technology in our own development effort; we must build a technical base as quickly as possible and establish a practical system with China's unique features. In order to reach the goal of the 1990's, it is necessary to import mid-level systems representative of the standard of the early 1980's. We can use these systems as a basis on which to build practical systems with Chinese characters and multiple reception capabilities, including high-level systems. Only through such efforts can we eventually solve the problem of modernizing China's seven inter-provincial network dispatching units, more than 20 provincial dispatching units and approximately 200 local dispatching units.

Basic Automation Must Precede System Automation

Li Naikuan [2621 0035 1401] (Deputy chief engineer, Central Dispatching, North China Power Management Bureau)

The effort to automate the control of the Beijing-Tianjin-Tangshan power network had an early start, but progress was very slow. In early 1981, the network was linked to the Shi-Han network of southern Hebei Province; in September, it was further linked to the Shanxi provincial network, thus forming a North China regional network. The linking of three networks in one year placed such heavy burden on the secondary systems that the original control systems could no longer meet the new requirements. Currently, only the North China central dispatching office has a set of remote operation and communication equipment capable of handling the information from the original Beijing-Tianjin-Tangshan network; the information from the Shi-Han network and the Shanxi network can only be partially processed by the central dispatching office. The main problem is with the secondary system (including the communications system) and the management system. The current system is a first-level SCADA system which contains a monitoring function but no control function. The dispatching office can only issue commands manually based on the received information.

Automation of the North China power network began in 1956. Specifically, remote operations were initiated using communication channels; by early 1960's, pulse frequency system remote sensing and contact type remote operation were developed, but they were not used because of their poor interference rejection capability. In the 1970's, under the sponsorship of the Institute of Electrical Science and the Beijing Low-Voltage Electrical Equipment Factory, a

WYZ digital remote sensing and communication device was developed and has since been certified for industrial production. It has been a highly reliable product and is being used today. The slow development process was attributed to poor scheduling and the lack of concentrated effort. The current WYZ has independent elements with distributed logic and uses the CDT format. Recently, it was recognized that the CDT format could no longer meet the needs of the three major networks and must be replaced by the polling format. This requires the use of microcomputers and the development of microprocessor remote operation. However, this time we must remember the lesson we learned and avoid diluting our efforts. In 1968, the North China network began using computers in power network automation. As a first step in the on-line application of computers, it used the Chinese-built machine DJS 121 with specially designed interfaces; while this project did not produce a reliable machine, it did produce a team of trained personnel. In 1978, a cooperative effort with the Nanjing Automation Research Institute produced the first SD-176 computer; although it was not a high performance machine, we continued its use until it was replaced by a dual SD-176. During the 1972-1978 period, with our attention concentrated on a single machine, it proved to be a satisfactory tool. We also built a good foundation for remote operation data transmission with the support of the WYZ remote operation systems and communication systems. In the 1960's, a 24-channel microwave communications channel was developed; by 1978, a 120-channel analog system was developed. Today, both microwave and multiple carrier communications systems are being used.

Power network automation may be viewed as a pyramid with communications at the base, remote operation (or what I call digital communication) in the middle, and computers at the top. The main difficulty with network automation at some locations is primarily associated with problems at the base. The so-called automation of network control actually means integration of these individual sections. The EMS has three modules: 1) the control center, which contains the on-line computer and the data collection and processing system; 2) the data transmission module, which contains both remote operation and communication; and 3) the basic automated plant operations. In my opinion, the main problems we have today are in the 2nd and 3rd modules. Remote operation must cover basic automation items such as converters and auxiliary contact points which really should be issues of plant automation. Imported technologies can improve the first two modules but not the third module. When the station transmits the kWh data through the RTU, all the electric meters must be modified in order to send out pulsed information. The switching quantities must be converted by relays from a.c. to d.c. and then undergo A/D conversion. Though not difficult, these tasks are rather tedious. If AGC is to be implemented, the generator plant must be equipped with power modulation devices and furnaces with automatic regulators. This in turn requires the operating personnel to be trained in power modulated dispatching operations. These two problems must be addressed when we begin using imported technologies in the four major networks. We must decide who will be responsible for addressing these problems; the inter-relationships between the individual departments must also be clarified. If we are to import 1970-1980 technologies and apply them to automation equipment built in the 1940-1950 period, clearly we cannot expect to achieve good results. We must emphasize coordination and considerations from the system viewpoint in pursuing power network automation. A signal transmitted through the network must be supported by every link of the

system. We hope that organizations at each level of the system will devote their attention to power network automation. It should be specified that new generators with capacities greater than 100KVA will be equipped with power modulation. As far as software are concerned, they can be tested as long as part of the generators have power modulation equipment. Since we are already performing off-line computations, it should not be difficult to achieve on-line control. We should also promote simulated training for dispatching personnel because the probability of conducting training during an emergency situation is very small. This should be one of the routine procedures of network dispatching automation.

The Key Issue Is Good Planning

Ding Daoqi [0002 6670 7871] (Deputy director and engineer, Dispatching Office, Northeast Power Management Bureau)

The Northeast electric power system has a generator capacity of more than 10 million kW; it has two provincial dispatching units, 14 local dispatching units, 13 major hydro and thermal power plants, and 18 transformer stations higher than 220 KV. Achieving dispatching automation for such a large network requires good planning. With the cooperation of the Institute of Electrical Science, the Nanjing Automation Institute, the Ministry of Electronics Industry, and the Shengyang Office of Automation, we spent a year in developing a systems engineering plan for Northeast dispatching automation. This plan has six unique features: 1) it is highly project-oriented, and contains implementation procedures, schedules, and estimates of annual investment; 2) it requires close coordination with research and development organizations so that the results of research can be applied in production; 3) it calls for the formation of a special organization--the Northeast network dispatching automation planning and implementation guidance group, which includes members of the Northeast Power Management Bureau, the Provincial bureaus of Heilonjiang and Jilin provinces, and the Institute of Electrical Science--to establish plans for expenditure, investment, and personnel; 4) it specifies the unification of computer types in order to facilitate the sharing of software and exchange of ideas, and to avoid duplication of efforts; 5) it has provisions to raise the standards of current basic automation including both the quantity and quality of communications channels and remote operations, as well as the automation of thermal electric plants; and 6) it stresses higher economic benefits in utilizing existing computers and automation equipment, and suggests the use of old equipment for training personnel.

To actually implement the plans, we must first solve four key problems. First, we must have commitments at all levels ranging from high-level officials to production units. At present, some organizations let their computers remain idle and their remote operation equipment unattended; some individuals have the attitude of just wanting to maintain status-quo. These are ideological obstacles to the implementation of the plans. Second, we must address the problem of coordination with the design, basic development, production, and research departments. Without the support of these departments, the dispatching department cannot successfully carry out its plans. For example, some organizations only pay attention to the development of primary systems but

ignore secondary systems; other large power plants have no communication network and must lease circuits from the Ministry of Posts and Telecommunications. Therefore, we must establish an organization with the authority to approve each plan and to ensure that the approved plans are carried out by all departments. Third, detailed plans must be established not only for the central dispatching office, but also for the provincial and local dispatching units as well as for the power stations. Fourth, we must take into consideration the practical payoff in carrying out each step of the plan.

Dispatching Automation Requires Overall Planning and Coordinated Development

Lo Yishou [5012 7328 1108] (Deputy chief engineer and senior engineer, Central Dispatching Office, East China Power Management Bureau)

I. The East China network began using on-line computer in 1978 as a tool for safety monitoring and efficient dispatching. Dispatching automation is a complicated technological task which cannot be easily accomplished by one organization. The automation of East China network dispatching was accomplished with cooperation from the Ministry of Water Resources and Electric Power, leaders of the Power Network Bureau, the Institute of Electrical Science, the Nanjing Institute of Automation, the Huadong Electric Power Experimental Research Office, as well as from six higher institutions and manufacturing plants. It was a large-scale socialistic cooperative effort.

II. As the power networks grow in size, their management become more and more complicated, and some of the existing equipment are no longer adequate. For this reason, the Ministry of Water Resources and Electric Power has decided to use imported equipment to speed up the automation process of network dispatching of the four major networks. In carrying out this task, we must do our best to apply imported technologies and coordinate with domestic equipment in order to achieve the goal of providing sufficient electric power to the three provinces and one major city.

III. To achieve automation of network dispatching, we must devote our efforts to the following two areas:

1) Although computer is a major component of the system, its utility cannot be fully realized if the other two components--remote operation and communication channel--are inadequate. A very important issue is good management of the new equipment. While there are many different types of remote operation equipment, only a few can meet the needs of dispatching. Remote operation equipment must be standardized and serialized.

2) Another fundamental consideration for dispatching automation is the automation of power plants. For example, the automatic generator control (AGC) system requires that each generator must have its own control unit. Most Chinese-built generators do not have this capability, and must be modified unit by unit, which is a very time-consuming and expensive process. It is suggested that this control capability be incorporated in future generator units which are larger than 200,000 kW. Although the initial cost would be higher, the total cost can be reduced by eliminating modification expenses. Such an approach would clearly benefit both the country and our industry.

Imported Equipment Must Be Carefully Implemented At The Ground Level

Xu Desen [1776 1796 2773] (Deputy section head and engineer, Automation Section, Central Dispatching Office, East China Electric Power Management Bureau)

The East China power network began its automation plan in 1974. Since 1975, it has experience in on-line monitoring. The computer used by the network was the Chinese-built 100 series machine, barely adequate for the job. The computer was equipped with input and output devices and a monitor; while it also had a magnetic disc system, its storage capacity was only 32K because of the large overhead; as a result, its real-time capability and CPU utilization rate were limited. During the 2nd phase work which is now underway, the O S will be modified to enhance its real-time capability. Originally, there were approximately 200 remote sensing parameters, 200 communication parameters, and more than 50 picture frames. When the 2nd phase work is completed early next year, there will be 460 remote sensing parameters, 800 communication parameters and an increased number of picture frames. However, due to the lack of supporting software, the data collection format and other elements must be modified as a result of the increased capacity. Furthermore, for each peripheral device added to the system, an additional port would be required; to build these interface ports requires a great deal of labor. To enhance the capability of the 100 series computer, it can be linked to a TQ-16 computer, which is a 48-bit machine. The TQ-16 computer can be used to perform the required analyses and the computed results can be returned to the 100 series computer. Because of the large number of peripheral equipment and the complexity of the system, its reliability and interference rejection capability are poor. Recently, we began a joint effort with universities to investigate state estimation and optimum dispatching. At present, line losses and load distribution are estimated based on experience, and no attempt has been made to achieve optimum dispatching. The importation of advanced technologies for the major networks is both timely and necessary. To take maximum advantage of imported technologies, we must develop compatible equipment to meet China's current needs. The Huadong Experimental Research Institute has initiated efforts to build interface ports for disc drives and CDT. Based on an overall plan which takes into account the needs of two provinces, it has completed the development of both SCADA and AGC functions, and is now working toward EMC.

The ground-level dispatching personnel must learn to use the imported equipment and become proficient with them. In a recent incident reported by the Edison Company, a warning to "lower the voltage and cut off the load" was given by the computer; but the operator on duty, being unfamiliar with computers, failed to carry out the instructions. The result was a major disaster. Therefore, as more imported equipment are introduced, we must also devote our efforts to the training of dispatching personnel.

Automation Of Power Network Dispatching Is Inevitable

Xu Youfang [6079 2589 2455] (Deputy director and senior engineer, Dispatching Office, Central China Electric Power Management Bureau)

The Central China power network was established just 3 and one-half years ago; it is centrally located, and will be linked to the four major networks. On

20 May 1979, the Central China power network came into existence by linking the Henan and Hubei networks. In January 1983, it was linked to the Jiangxi network, and by the end of this year, it will be linked to the Hunan network. Its capacity now approaches 10 million kW; it has 600 km of 500 KV lines, and the system has been operating for almost a year. The seven generator units at Gezhouba have a total capacity of 965,000 kW. In addition to the intra-network links, it will also be linked to the North China network this year, and to the East China network with 1000 km of d.c. transmission lines, as well as to Sanmenia with 330 KV lines. The Central China network currently has no computers; the Hubei provincial dispatching unit has imported a CLASSIC 7830 system.

Because of the poor standard of network dispatching, we have learned our lessons from numerous accidents. The 727 accident of the Hubei network caused the collapse of the entire network, and resulted in losses of tens of millions of yuan. The Hunan major blackout and the Central China 8.7 accident last year also resulted in great losses. These accidents clearly indicate an urgent need for the automation of power networks. However, it is not sufficient just to have advanced equipment, we must also have a modern command system or a modern dispatching system. Gezhouba is a run-off type power station whose operation cannot be interrupted. The "Chang Jiang is a river that carries with it coal and oil" as the saying goes. The Danjiangkou hydroelectric plant has a small reservoir; if dispatching is not done properly, it may suffer loss of water resources. Being centrally located and linked to all the major networks, improper dispatching of the Central China network will affect power networks of the entire nation. Because of hardware problems with Chinese-built computers, it is necessary to use imported equipment; but in the future we should develop our own capability. The key issue today is to train qualified personnel.

Not only must we train technical personnel, but also operators and administrative personnel such as leaders of the Electric Power Bureau and the provincial economic committee. There are individuals today who still oppose giving high-level officials the authority to control the overall situation, because once automation of network dispatching is completed, leaders at various levels can have access to all the information of the network via the computerized remote operation system. Operational personnel should understand computers; conversely, computer personnel should be knowledgeable in electric power systems.

Personnel Training For Automation Of Network Dispatching Should Be Emphasized

Fei Zhongdi [2431 6988 2769] (Deputy director and senior engineer, Dispatching and Communications Bureau, Ministry of Water Resources and Electric Power)

I would like to offer my opinions concerning the training of personnel for automation of power systems.

I. The Problem of Establishing a Specialty Field

Training of personnel for the automation of power network dispatching is the responsibility of schools, production units, and research organizations, but

primarily it relies on schools. In recent years, there have been significant changes. The Haubei Electric Power Institute is the only school that offers a special curriculum in power system automation. The Chengdu Technical University initially offered a specialty in communication and remote operation, but later changed it to information engineering; as a result, it does not specifically reflect remote operation and computer, i.e., it does not clearly identify the training objective. The Ministry of Education and the Department of Education are in the process of unifying the names of specialties across the nation. It is my opinion that the scope of a specialty should not be too narrow, a mistake often made in the past. The specialty of automation of power network dispatching should include knowledge in the following areas:

1. Knowledge of first-order systems should be emphasized. In the past, schools pay little attention to first-order systems; without a good understanding of the overall power system operation, it is impossible to pursue knowledge of second-order systems.

2. A solid foundation in basic knowledge is essential; one should not limit his effort only to a very specialized technology.

3. Knowledge in computer and remote operation should be strengthened. Today's schools do not pay enough attention to remote operation; there are no courses offered in this field. One can expect that there will be a shortage of personnel in this area. A survey shows that currently there are about 1000 people working in the area of remote operation, including 200 engineers and over 600 technicians; however, a significant percentage of them are actually unfamiliar with remote operation technology.

II. Methods of Training

There are three ways to accomplish personnel training: college training, vocational training, and amateur training. In particular, more efforts should be devoted to vocational training. The Nanjing School of Electric Power produces many students, but they cannot be assigned to other provinces. Students graduated from vocational schools are quite effective; for example, vocational students assigned to the Bureau of Dispatching all performed very well. Computer training is in rather good condition, but very few people are formally trained in remote operation. To raise the knowledge level of over 1000 personnel, we must rely on the Employee's College.

I also want to discuss three additional points:

1) Software, particularly application software, play an important role in using computers. Personnel in the power system industry should learn to use computers as well as the general knowledge about computers. Dispatching operators are no exception.

2) Currently, there are about 1000 remote operators who urgently require advanced training. Many of them feel unqualified for their jobs. In most cases, the instability of their work affect the development of remote operation. This problem should be addressed by the Ministry and its departments.

3) Since very few people can receive training at a regular college, a form of on-the-job training must be considered. I think the best form is a short-duration training class. However, how to coordinate the training classes with individual's academic background must be given careful consideration.

3012
CSO: 4013/200

BRIEFS

SHANXI 500KV POWER LINE--Construction of a 500KV ultrahigh-tension power transmission line between Shentou power plant and Datong No 2 power plant--two large pit-head power plants of Shanxi Province--was initiated on 1 September. Upon completion, this power transmission line and the second 500KV power transmission line between Datong and Beijing, which is being built simultaneously, will link the Shanxi power grid with the North China power grid and boost the power supply capacity of the two large power plants in the province's Yantong power base to Beijing, Tianjin, and Tangshan to some 2.55 million kilowatts. [Summary] [Taiyuan SHANXI RIBAO in Chinese 2 Nov 84 p 1 SK]

NEI MONGGOL 220KV POWER LINE--The construction of the 220KV Tongliao-Horqin Right Wing Middle Banner section of the Tongliao-Huolinhe power transmission line was completed and passed its acceptance test recently. This 195.49-km long power transmission line went into operation on 28 November. The construction of the Horqin Right Wing Middle Banner-Huolinhe section will be completed by July 1985. [Summary] [Hohhot Nei Monggol Regional Service in Mandarin 1100 GMT 29 Nov 84 SK]

GUIZHOU 220KV POWER LINE--Two years under construction, another large power transmission and transformer project--the Guiyang-Kaili 220,000-volt power transmission and transformer project--was completed and made available to users on 21 November. This project mainly includes a 130-kilometer-long transmission line, and the Kaili transformer station. After this project is put into operation, the amount of power supplied will be some 200 percent more than the amount of the original load. Thus, safety in and reliability of the supply of power in Qiandongnan and Qiannan Autonomous Prefectures will further improve and the supply of power for construction of the Hunan-Guizhou electrified railroad will be guaranteed. [Summary] [Guiyang Guizhou Provincial Service in Mandarin 2300 GMT 22 Nov 84 HK]

CSO: 4013/49

STATE PLANNING COMMISSION APPROVES RESUMPTION OF BAOZHUSI PROJECT

Chengdu SICHUAN RIBAO in Chinese 6 Nov 84 p 1

/Excerpts/ At the behest of the State Council, the State Planning Commission has recently approved the placing on this year's consruction agenda of the Baozhusi hydroelectric power project. This is the second joint large-scale power project to be undertaken by the State and Sichuan Province following the expansion project of the big Baima Power Plant.

The Baozhusi hydroelectric power station is located on the mainstream of the Bailong Jiang in Guangyuan County, part of the Jialing Jiang river system, and is the second cascade power station called for in the plan. Primarily for power production, this large-scale hydroelectric power project will also serve irrigation and flood prevention and provide a source of water for comprehensive economic benefits. The reservoir will have a capacity of 2.5 billion cubic meters, making it the largest reservoir either completed or under construction in the province. It will have a seasonal regulation capacity. /The power station/ will have a total installed capacity of 640,000 kilowatts for a yearly power output of 2.278 billion kilowatt-hours. Through reservoir regulation the 100-year flood crests will be reduced by 36 percent. This huge reservoir could supply the grain and cotton growing areas of Sichuan Province between the Jialing Jiang and the Qu Jiang, an area of some 2 million mu, with more than a billion cubic meters of water for irrigation. It will also improve transportation on the Jialing Jiang from the northern to the eastern part of the province, downstream agricultural production, and the people's daily water needs. The time from the construction preparation until the first generator begins to generate electricity will be 8 years.

After the power station has been constructed, it not only will provide a big boost for the province's economic growth in the 1990's, but also vastly improve the operation of the power network, providing a safe and reliable source of electricity.

This hydroelectric power station was designed by the Northwest Survey and Design Institute of the Ministry of Water Resources and Electric Power and is the responsibility of the Water Conservancy and Hydropower Construction Company of the Ministry.

The initial planning and investigation on the project were completed back in 1977 and it was placed on the State Plan construction agenda the following year and preparations were made to begin construction. Work then stopped due to /economic/ readjustment.

CSO: 4013/50

WAYS TO SHORTEN PRE-CONSTRUCTION STAGE SUGGESTED

Beijing SHUILI FADIAN [WATER POWER] in Chinese No 8, 12 Aug 84 pp 3-6

[Guo Zongyan [6753 1350 1750]: "Some Suggestions on Shortening the Pre-Construction Stage of Hydropower Stations]

[Excerpts] The construction period of a hydropower station is generally divided into the pre-construction stage, or the time period from the beginning, when external communications and subsidiary enterprises are built, to the time when work on the principal project begins; the peak construction stage, or the period from the time when work on the principal project begins to the time when the first power unit generates electricity; and the wind-up stage, or the period from the time the first power unit generates electricity to the time when all generating units have been installed. Added together, these three stages are called the total construction period.

The time used in the peak construction period of China's large and medium-sized hydropower stations is generally 5 to 10 years, which is essentially similar to the situation abroad. The time used in the wind-up period is mainly determined by the power usage conditions of the local power grid of a hydropower station, the speed of machining and manufacturing of the generating units, and the succeeding arrangement of the construction contingents, which is also not too different from that abroad. The main difference is that the pre-construction period in China is longer than that abroad. According to incomplete statistics, the pre-construction period of large- and medium-sized hydropower stations abroad is generally from 1 to 4 years. It is shorter in the United States and Canada, which take from 1 to 2 years, and longest in the Soviet Union, which takes 2 to 4 years. Their proportions in the total construction period are 15 to 30 percent in the United States and Canada and 25 to 40 percent in the Soviet Union.... The pre-construction period of China's large and medium-sized hydropower stations is largely similar to the Soviet Union, which also generally takes 2 to 4 years and represents about 30 percent of the total construction period.

The pre-construction stage of hydropower stations in the United States and Canada is not merely shorter; the quality of various projects completed are higher. They pay particular attention to sand and stone materials, concrete mix and the quality of construction and installation of system engineering projects. It generally takes only 1 to 2 years from concreting to the peak

construction stage, and the peak may come as early as the same year. Not only does this safeguard the construction quality of foundation concrete in the principal project but also speed up construction of the entire hydropower station. For example, the Libei Hydropower Station in the United States has an installed capacity of 840,000 kilowatts and its dam and workshops have a total of 3,230,000 cubic meters of concrete. Its preconstruction period was 2 years. In April 1968 concreting of the dam began and by the end of the year it reached the peak, having poured a total of 855,000 cubic meters of concrete or 26 percent of the total volume of concrete. The Dworshak Hydropower Station in the United States has an installed capacity of 1,060,000 kilowatts and its dam and workshops have a total of 6,125,000 cubic meters. Concreting of the dam began in 1968 and the total volume of concrete poured in 1969 was 2,210,000 cubic meters which represented 43 percent of the total volume of concrete. By comparison, the peak of the concreting of the dam for some of China's hydropower stations usually comes 2 to 3 years after concreting of the first side. Before the formal concrete mix and systematic production, some hydropower stations use temporary concrete mix and systematic concreting of the first side of dam and foundation concrete. This often results in poorer quality of the foundation concrete of critical dam areas than that of the concrete of the upper part of the dam. In some cases it is even necessary to blast away part of the foundation concrete which affects the construction schedule. Therefore, shortening the pre-construction stage is a key link in shortening the construction time for China's hydropower stations and in lowering construction cost.

Why is the pre-construction stage of hydropower stations in China longer than that abroad? An analysis of the causes are as follows. First, the construction contingent is massive, the number of service personnel is large and work efficiency is low. The construction of hydropower stations in the United States and Canada largely adopts the form of contracting with engineering firms. In some cases, a general contracting firm would contract out various portions of a project among various specialized firms. Each specialized firm has its own professional and technical contingent, base, as well as assembly-disassembly plant buildings, mobile living quarters, modern and special construction machinery and equipment and an ample supply of parts. When they complete their contracted tasks in accordance with the schedule and quality requited, all specialized firms would immediately evacuate the project site. However, the organization of China's construction contingent for hydropower stations involves essentially a single engineering bureau which is responsible for the construction of one hydropower station. When a station is basically completed, almost all the contingents of the entire bureau are successively moved to a station which begins construction. Not only does this make the task of building living quarters in the pre-construction stage enormous, it can never give full play to the professional and technical strength of various types of work. For example, during the dam foundation excavation period it is hard to give play to the professional skills of concrete and installation workers; in the dam concreting period, excavation and installation workers cannot make use of their professional skills; and in the period of installing generating units, excavation and concrete workers also find it hard to play their role. Therefore, in the

entire construction period of a hydropower station, the average productivity of each type of work is low. Second, the capital of the pre-construction stage is not guaranteed. Because the construction of hydropower stations in the United States and Canada largely takes the contractual form, the capital of the pre-construction stage is assured. In China, however, the total capital of some hydropower stations is 500 million to 1 billion yuan, sometimes the capital for the pre-construction stage is only several million or 20 to 30 million yuan. This makes it difficult to assure successful pre-construction projects and as a result construction time is prolonged. Third, subsidiary construction enterprises are large and complete. In the United States and Canada, subsidiary enterprises at the project site in the construction of hydropower stations are merely responsible for changing damaged mechanical parts. This is done on a small scale and the plant buildings of many subsidiary enterprises and the living quarters of staff and workers are usually of the assembly-disassembly, container or mobile types. The engineering workload in the pre-construction stage is therefore small and does not take too long. However, in China the construction of each large or medium-sized hydropower station requires the building of massive subsidiary enterprises that can undertake all machining and repair jobs. Moreover, plant buildings are of brick structures, which not only prolong the pre-construction stage but also increase the cost of the entire hydropower station.

In order to shorten the pre-construction stage of China's hydropower stations, other than doing our best in design and other preliminary work, construction planning, cooperative external relations as well as strengthening administration and management, carrying out the economic responsibility system and relying on technical progress, we should combine current construction conditions in China in accordance with experience at home and abroad and put forward the following proposals:

1. Build construction bases for hydropower stations according to region

Under the prerequisites of doing our best in planning, prospecting, design and scientific research ahead of schedule in developing hydroelectric power, we should realize cascade development along rivers as much as possible so that each engineering bureau can simultaneously construct three hydropower stations. One station will be in the wind-up stage of installing generating units, another in the peak construction stage of filling and constructing the principal project and a third in the pre-construction stage of bringing in a power and water supply, roads and site leveling. Not only can this give play to the professional skills in various types of work over a long period of time but can also continuously improve the technical level and productivity of different types of work. On this basis, it is estimated that the number of construction workers for each hydropower station can be reduced by about two-thirds with a corresponding reduction in housing construction area and the utilization rate of existing construction machinery and equipment can be increased. If we can complete the development plan and program of the three cascade hydropower stations ahead of schedule and build a production living base which conforms to local natural conditions at a selected location that will suit the construction of the three stations,

then the pre-construction stage of hydropower stations and the entire construction period of the cascade development can be shortened. The construction base should include: (1) a building and repair plant responsible for the major overhaul of construction machinery and equipment of the three hydropower stations and for producing the non-standard products and steel structures needed by the hydropower stations; (2) a timber processing plant which will produce standard form-works and refined processed wood structures; (3) a prefab concrete components plant which will produce various reinforced concrete prefab components; and (4) a building construction integrated plant which will produce assembly boards and complete housing parts for the plant buildings of subsidiary enterprises. Retired workers can be arranged to spend their later years joyfully at the base, some of the old and physically less capable workers can engage in production at the base, and the children of staff and workers can study at the base schools or work at the plants at the base. But building such a production and living base require a long period of time. In order to shorten the pre-construction period of hydropower stations which begin work in the short run, it is imperative that we popularize the construction experience of the Hongshi Hydropower Station. This will not only reduce the capital of a hydropower station and increase its progress but also resolve the problems related to uneven busy and idle periods of the various types of work of an engineering bureau.

2. Establish specialized hydropower construction corporations

Based on existing nationwide specialized construction corporations, we should successively set up specialized corporations in pre-construction engineering, earth and rock engineering, concrete engineering, underground engineering and metallic structure installation engineering and provide them with adequate technical strength, large modern construction machinery and equipment, assembly plant buildings and mobile living quarters and constantly improve their technical level which will rapidly increase their productivity and construction quality. According to Soviet data, the productivity of specialized construction contingents is 50 percent higher than that of ordinary construction contingents. The construction of some hydropower stations can adopt the bidding method so that all engineering bureaus and construction corporations can request bids on individual projects or joint bidding. This will foster competition among all construction units and promote the development of China's hydropower undertaking.

3. Ensure investment for the pre-construction stage

Delay in the construction period and increase in investment for some hydropower stations primarily occur in the pre-construction stage. Clearly, for a construction contingent which has as many as 10,000 people, each year's delay in the pre-construction stage will mean about 10 million yuan and at the same time flood prevention and drainage work volume at the construction site will correspondingly increase. Therefore we must ensure the capital outlay needed for the pre-construction stage. In recent years, in order to resolve the problem of shortage in construction investment for hydropower stations, the Soviet Union has begun to use the method of allocation

according to the proportions of benefits for centers of comprehensive utilization by allocating the investment for common portions of the hydropower station project among participating departments and the regional governments in concern. In general, power generating departments of hydropower stations are responsible for 75 to 80 percent of the total investment while individual power generating departments of hydropower stations undertake only 50 percent. This will rationalize the scale of navigation locks, fish passes, timber passes and other hydro-engineering structures and will favor reduction of the investment on hydropower stations. In view of China's present actual conditions, we propose to select one or two hydropower stations as experimental points for investment sharing.

4. Improve the structures of plant buildings of subsidiary enterprises

Subsidiary enterprises of hydropower stations in the United States are all small in scale. Their structures are usually the assembly-disassembly type. For instance, the assembly-disassembly machinery overhaul workshops (including the administrative office) of Canada's Church Falls Hydropower Station has a mere construction area of 24 by 48 meters. In recent years, the Soviet Union has also been popularizing assembly-disassembly plant building structures of subsidiary enterprises. The ones primarily in use at present are the YTC-420-06 model and the BYTC20-00 model. According to the experience of the Toktogul Hydropower Station in the Soviet Union in using the assembly-disassembly plant building structures of subsidiary enterprises, even though the initial investment on such structures are large, compared to brick structures, labor consumption of the latter is 3 times greater than the former and the volume of materials transferred is 4 times greater. For instance, construction of a 12 by 72 meter assembly-disassembly plant building structure of a subsidiary enterprise would merely take 945 workdays while a brick structure would take 3,920 workdays. Based on China's actual conditions, we propose organizing part of the design and processing capability, select suitable work sites and make experimental use of assembly-disassembly plant building structures of subsidiary enterprises.

5. Adopt large modern construction machinery and equipment

Practice and experience at home and abroad have demonstrated that strengthening the maintenance and repair of large modern construction machinery and equipment, implementing regular preventive overhaul according to projects completed by various machinery and equipment and increasing their rate of utilization so that their daily utilization time reaches 18 to 20 hours will achieve the goal of reducing the quantity of construction machinery and equipment and reducing the scale of machinery repair plant and other subsidiary enterprises, and it will correspondingly shorten the pre-construction stage. In recent years, large construction machinery and equipment of hydropower stations used abroad include: bucket excavators with an output of 2,500 cubic meters per hour; high-speed heavy-duty drilling machines with a velocity pressure of 49.47 jin per square centimeters and a drilling speed of 45.6 meters per hour; 10 to 11.5-cubic-meter single-bucket excavators; 385-to 700-horsepower bulldozers; 100 to 110 metric ton dump

trucks and 57.5-cubic-meter earth-moving machines; 1.37-meter-wide and 19.7-kilometer-long band conveyor; 50- to 100-metric-ton pneumatic tire rollers and 16-metric-ton vibration rollers; high-speed cable machines with a speed of horizontal motion of 450 to 670 meters per minute and a speed of vertical motion of 104 to 290 meters per minute; and hardrock tunnellers with a diameter of about 10 meters. We should consult the experience of the use of large modern construction machinery and equipment abroad, improve and update and make existing construction machinery and equipment complete with planning and in steps in order to increase the speed of construction. Besides, in order to reduce the quantity of construction machinery and equipment we must store ample supply and variety of equipment parts at the construction site. According to American statistical data, the investment on construction machinery and equipment replacement parts of most hydropower stations in the United States constitutes about 30 percent of the total cost of construction equipment. On-site overhaul of machinery and equipment is actually changing replacement parts. We should also exert our efforts in this direction.

9586
CSO: 4013/223

ECONOMIC CONSIDERATIONS OF SHUIKOU RESERVOIR FLOODING DETAILED

Beijing SHUILI FADIAN [WATER POWER] in Chinese No 6, 12 Jun 84 pp 14-16, 63

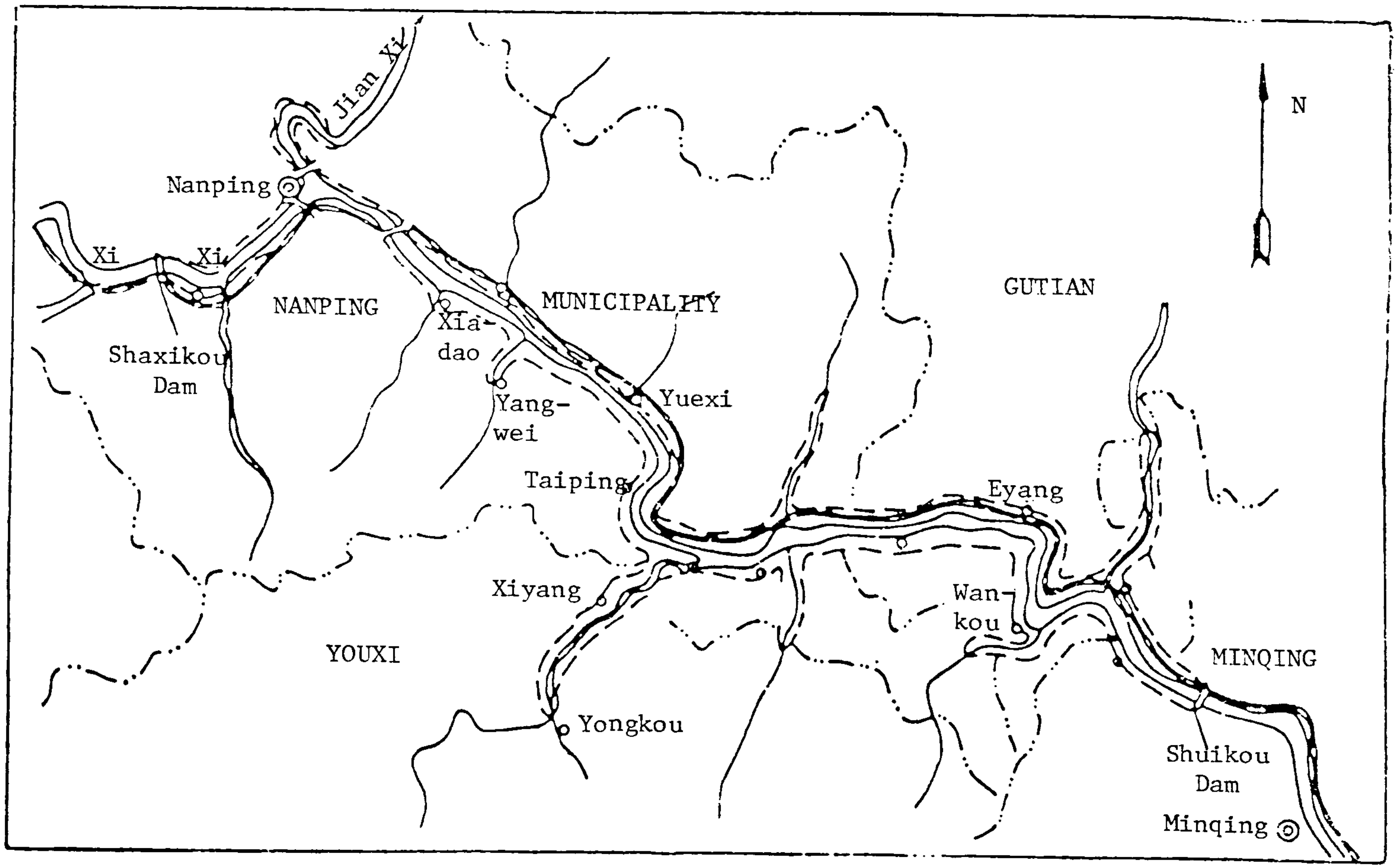
[Article by Mo Guohan [5459 0948 3352] of the East China Survey and Design Institute, Ministry of Water Resources and Electric Power]

[Summary] The Shuikou Hydroelectric Power Station is the largest hydroelectric power station in the East China region now in the early stage of development. Situated on the main stream of the Min Jiang, it will have an installed capacity of 1.4 million kilowatts and generate 4.95 billion kilowatt-hours of electricity annually. In normal times, when the impounded water stands at 65 meters, the volume of the reservoir will be 2.34 billion cubic meters covering an area of 93 square kilometers. The area inundated by the reservoir will include parts of the three counties of Minqing, Gutian, and Youxi, and Nanping City. For the scope of the inundated area, see the accompanying map.

For reservoir inundation data, at the time of the preliminary design (1979-1980), the Survey and Design Institute and the local government carried out on-the-spot investigations, which found that 31,000 mu of cultivated land would be inundated and 54,000 people would be displaced (projecting up to 1985). In 1983, when drawing up resettlement plans for displaced people, they did a complete re-investigation, and when the results of the re-investigation (see accompanying table) were compared with the initial survey data, it was found that the number of displaced people had increased 7 percent and the amount of inundated cultivated land by 4.3 percent. This article introduces the methods and actual experience of the rural resettlement plan for the Shuikou hydroelectric power station in the drawing up of the budgetary estimate.

I. The Resettlement Plan

1. The resettlement plan entails important work to guarantee that the displaced people obtain appropriate resettlement and its purpose is to enable the national economy in the inundated area to recover and develop in a planned manner so that production and the standard of living of the displaced people as well as the residents of the resettlement area does not drop due to reservoir inundation. Consequently the resettlement plan must be carried out in accordance with local natural conditions and resources. After a comprehensive analysis of the area to be impacted on by the Shuikou reservoir, we feel that the resettlement plan



Map showing area to be flooded by the Shuikou Reservoir

Table: Major Items To Be Inundated by the Shuikou Reservoir

Item	Quantity
Number of displaced people	57,715
--From flooded area	54,129
--Affected by flood	3,586
Flooded cultivated land (mu)	31,394
Flooded barren land (mu)	11,083
Flooded timber land (mu)	10,196
Flooded commercial forests (mu)	4,124
Flooded fruit trees (10,000)	13.73
Flooded buildings (10,000 m^2)	264.96
Private homes (10,000 m^2)	194.74
Collectively held buildings (10,000 m^2)	39.81
Enterprise held buildings (10,000 m^2)	30.41
Flooded small-scale hydroelectric stations (kilowatts)	1,971

should consider the following aspects: 1) There are many people (an average of 0.7-0.8 mu per capita) and little land in the area influenced by the Shuikou reservoir. Part of the labor force is already using the Min Jiang for log rafting, transportation, fishing, and other work. In the reservoir area, the non-agricultural rural population is about 20 percent, and after the reservoir inundation the problem of population density will become more pronounced. 2) Since the implementation of the agricultural responsibility system, land has already been distributed through contracts, and so it has become quite difficult to realize resettlement of displaced people through land transfer, being possible only in a small number of communes that have relatively more land. 3) Displaced people in the reservoir area are not willing to move far, to maintain their original system.

2. Given the above situation, the principles of the resettlement plan have been set by the province, as follows: 1) As much as possible, resettlement is to be within the boundaries of the home county (city) or home commune, nearby, on high ground. 2) In principle, all those required to transfer cultivated land, mountain land, or water surfaces, a balance within the home county (city) or home commune is to be created. 3) As much as possible, resettlement should be in accordance with the original occupations of the displaced people. 4) The plan must fully consider all positive factors and settle matters appropriately, to avoid further moving. In line with the above principles, the key is in implementing an outlet for production. We may not simply remain on presently cultivated land and carry out a plan for increased grain production. We must use the concept of "agriculture in the broad sense" and fully utilize local natural resources with a diversified economy of farming, forestry, animal husbandry, sideline occupations and aquaculture. There is not much

cultivated land along the banks of the Min Jiang but there are abundant mountain and water resources to develop a diversified economy. We cannot reduce the present level of economic return, but must have the state solve the problem of the grain ration.

3. The content of the Shuikou reservoir resettlement plan contains primarily the following points: 1) On the foundation of the original production plan of the resettlement area, the agricultural production plan has been formulated to speed up the development of production, raise the output per unit area, and, where conditions permit, allow reclamation of wasteland and the expansion of the cultivated area. 2) A diversified economic plan such as the creation of forests, cultivation of vegetables, development of orchards, and cash crops, utilizes the reservoir inlets to develop aquaculture and may also be suited to the setting up of communes and brigade enterprises for the resettlement of displaced people. 3) Moving the residential area should be beneficial for production, convenient for livelihood, and economical in land use; cultivated land should not be occupied. 4) The moving and construction plan for the commune or township should be based on the scale of the original commune or township. The eight communes and townships that must be moved because of flooding require that the selection of the new site take into consideration a well-situated location, suitable topographical and geological conditions, convenient communication and assured water and electricity. 5) In order to facilitate the development of installations required for production and daily life such as roads along the perimeter of the reservoir, bridges, ferries, docks, etc., along with the supply of water and electricity to the residential areas, the plan for transportation and the supply of water and electricity must go through a process of investigation and study in order to put forth a rational plan.

4. The organization of the Shuikou reservoir resettlement plan is to be carried out by specialized personnel from specialized departments in the reservoir area's counties (and city) to include agriculture, forestry, water, communications, capital construction, commune and brigade enterprises, etc., with each specialization suggesting various separate plans. They should put forth written reports on resettlement conditions for the displaced people, resettlement plans, feasibility analyses, calculations of the number of people that can be accommodated, along with an estimate on population growth by the year 1990. All of this is to be passed to higher authorities once it has been studied by the local commune. Selecting new locales for the commune or township's move and new construction, must be made by having leaders of each county's (city's) party committee, county (city) government, people's congress, and CPPCC go for an on-site investigation and discussion.

Summing up the above plan, the composition of the Shuikou reservoir resettlement plan is: farming, 51.5 percent, forestry, 7.8 percent, commercial fruit trees, 14.2 percent, animal husbandry, 1.7 percent, fishery 0.4 percent, industry and sideline occupations, 10 percent, and other non-agricultural populations, 14.4 percent.

II. Budgetary Estimates for Compensating Displaced People

After obtaining flood data and implementing a resettlement plan, compensation for the displaced people must be calculated. First, we must determine the compensation principles and standards, and to this end--in accordance with the relevent national regulations and referring to compensation standards for reservoir resettlement both within and outside the province--draw up a draft soliciting opinions for "Provisional Regulations on the Issue of Resettlement Plans for People Displaced by Large and Medium-scale Hydroelectric Stations in Fujian Province," and widely solicit the opinions of various departments in the province and various counties (cities) in the reservoir area. A work conference on resettlement plans for the Shuikou hydroelectric station must be convened and our consensus on the principle and standards for compensation reached. The principles to be considered in drawing up the budgetary plan for compensation to the rural population to be displaced by the Shuikou hydroelectric station are: calculate the quantity and quality of flooded materials according to current national policy. The resettlement plan should select a program in accordance with the compensation (use) and not according to needs of the plan. For certain projects for which it is difficult to make prior estimates of flood loss yet must still be considered in the resettlement plan, such as roads, bridges, fords, and docks, along with the supply of water and electricity to the resettlement area and certain necessary public facilities, we must rationally calculate compensation according to the resettlement plan. Here we will briefly explain the principles and methods for calculating compensation for various projects.

1. Land compensation. 1) Compensation for paddy land and dry field land must be calculated strictly in accordance with the "Ordinances on the Requisition of Land for National Construction," with the land requisition fee and the resettlement compensation fee together being calculated at 9.08 times the annual output value of the land in question. The per-mu yield is to be calculated according to the average value in the 1980-1982 report forms, and will also take into consideration the difference in per-mu yield inside and outside the reservoir area, further adding growth in yield at an annual rate of 2.5 percent; in addition, we will add compensation for crops and sideline products. 2) Apart from calculating the land requisition fee and resettlement compensation fee in accordance with regulations for cash-crop vegetable land, we will also requisition land according to national regulations and also plan a vegetable land construction fund. 3) Compensation for wasteland will be calculated at one-half the compensation fee for paddy land (paddy land is calculated at 2.5 times the annual paddy field output value) and no resettlement compensation fee will be calculated.

2. Cash crop fruit tree and forest land compensation. 1) For collective forest land, commercial forests, and young forests we will only compensate the cost of production; for mature forests, we will only compensate the cost of felling and transportation; for partly mature trees, we will compensate the cost of production plus 60 percent of the felling and transportation costs; the resettlement fee per-mu will be calculated at one-third the output value for paddy land. 2) For collective commercial forest land, we will calculate the compensation fee and resettlement subsidy according to the "Provisional Regulations" which are generally three to four times the annual output value, and the resettlement subsidy calculated at one-half that of paddy fields.

3) As most fruit trees are scattered in front and behind the homes of commune members, we will only calculate a compensation fee and not a resettlement subsidy. The compensation standards will generally be calculated at three to five times the output value of the fruit trees, with the annual yield determined by a comprehensive analysis of survey data.

3. Building reconstruction costs. Compensation will be based on the construction area and standards of the original structures of the reservoir area, after deducting for useable old materials. The method of calculation is: survey the new construction costs of various kinds of buildings (mixed/composite, brick and wood, frame, mud and wood, etc.), estimate the average rate of dismantling present buildings in the reservoir area, then calculate the value of usable old materials from the original buildings and the dismantling and transportation costs of the old materials and compute the compensation fee for buildings of various composition and style, thus: the cost of new construction minus dismantling the old minus the usable old materials plus the dismantling and transportation costs for old materials equals the compensation cost. We will compute the cost of new construction for each average square meter of various types of buildings in the entire reservoir area using a weighted average. The overall average rate for dismantling current old buildings for the whole reservoir area is 27.51 percent, the average rate of utilization for old materials is 22.52 percent, and the average dismantling and transportation cost is 2.94 yuan per square meter. When you also add the cost of leveling the ground and calculate the general cost of enclosures in front of and behind the building, the average rate of restoring reservoir area buildings is 55.55 percent. Within the granary/reservoir area, the average per capita area reaches 41.7 square meters (including private homes and collective enterprise buildings). Projecting an average per capita area for new buildings and restoration at 23.2 square meters, when you add the use of old materials, then the rate of restoration can exceed 70 percent and the per capita area of rebuildings is about 30 square meters.

4. Compensation for moving enterprises and displaced people. 1) The loss from moving enterprise units will be calculated at 20 percent of the enterprise units' fixed assets. 2) Transportation costs for institutions/enterprise units and business units will be calculated according to the distance of the move, with the cost of wear and tear from moving at 20 percent of the transportation cost. 3) Loss of wages through lost working time will be repaid at one month's average wages. 4) Tax and profit allowance for stopping production will be at one-third the amount of tax and profit influenced by the production stoppage. 5) The moving allowance for displaced people will include the three items of transportation expenses, losses incurred in moving, and a livelihood subsidy for lost wages.

5. Other compensation expenses. 1) Compensation for small hydroelectric stations and electrical irrigation stations. 2) Restoration expenses for communication within the reservoir area. 3) Restoration expenses for water used in production and daily life. 4) For those who had lighting before the construction of the reservoir, we must calculate the restoration expenses of electricity used for lighting. 4) Compensation for other public facilities, such as grain-drying yards.

III. A Few Points From Personal Experience

1. Having reliable data on the inundated objects is an important condition for determining the scope of the project, and is also the basis of the resettlement plan for the people displaced by the reservoir and of formulating budgetary estimates. It is extremely important not only in the planning stage but also after the project has been constructed. Since the villages have implemented the responsibility system, the degree of difficulty has increased for the work of investigating for data on inundated objects, and the planning units must clarify the data for these objects with the support and cooperation of the local government. Just as in the earlier surveying and planning for the hydroelectric station to obtain basic data on the geology, topography, and hydrology, they should also give priority to the work of thoroughly investigating reservoir inundation and give it the necessary guarantees in regard to time, resources and funds.

2. Organizing a specialized planning contingent with the local government as the key link and having planning institutes do a good job with their coordination work are important conditions for doing a good job with the planning work for the resettlement of people displaced by the reservoir. The resettlement of people displaced by a reservoir touches upon the entire disposition of the national economy in an area and concerns the personal interests of the masses and so must rely in the leadership of the local government for organization and implementation. Consequently, the resettlement plan for people displaced for a hydroelectric station must be carried out primarily by the local government and the responsibility of the planning unit is to give advice.

3. Doing things strictly according to party and state principles, policies, and laws and correctly handling the relations between the state, collective, and individual are the guiding thoughts in drawing up budgetary plans for compensation for inundation due to the reservoir. Before the Third Plenum of the 11th Party Central Committee, the compensation standards for people displaced due to the construction of reservoirs tended to be fairly low, with not enough attention paid to the interests of the masses. In the past few years, there has been a very major change in the situation. At present, the compensation standards for people displaced by reservoirs, compared to the past, is not just one time but several times greater.

12452
CSO: 4013/193

HYDROPOWER

SMALL HYDROELECTRIC STATIONS HELP RELIEVE RURAL POWER SHORTAGE

OW070642 Beijing XINHUA in English 0631 GMT 7 Dec 84

[Text] Beijing, 7 Dec (XINHUA)--China now has more than 76,000 small hydroelectric power stations, producing an annual average of 20 billion kilowatt-hours of electricity.

These stations, with a generating capacity of up to 12,000 kilowatts each, have been built in 1,500 of China's 2,100 counties, according to the CHINA ENVIRONMENT JOURNAL.

Of these, 100 have been chosen to pioneer rural electrification by building small hydropower stations which can generate electricity from waterheads of just a few meters.

The building of small power stations--those with a generating capacity of less than 500 kilowatts in particular--is encouraged to help alleviate energy shortages in the countryside.

Half the country's rural households suffer from shortages of firewood and other fuel for up to 4 months a year, according to the journal.

CSO: 4010/40

THERMAL POWER

DOUHE POWER PLANT THIRD STAGE SAID COMPLETED

Beijing XINHUA in English 0855 GMT 18 Dec 84

[Text] Shijiazhuan, 18 Dec (XINHUA)--North China's largest thermal power plant has just completed its third construction stage by adding the sixth 200,000-kW generating unit.

The Douhe thermal power plant, located near the north China industrial city of Tangshan, now has six generating units with a combined generating capacity of 1.15 million kW.

Construction of the plant began in December 1973. Four units with a total generating capacity of 750,000 kW installed in the first two phases of construction went into operation in 1978. Most of the equipment was imported.

Both the fifth generating unit, which began production last December, and the sixth were domestically manufactured.

The operations of the plant are largely computerized.

Preparations for the fourth stage are going ahead and the seventh 200,000 kW generating unit is scheduled to go into operation in 1986

CSO: 4010/45

BRIEFS

NEW LIANCHENG GENERATORS--Lanzhou, 29 Nov (XINHUA)--Two 100,000 kilowatt-generating units have been put into operation at the Liancheng steam power plant 147 kilometers from Lanzhou, capital of Gansu Province, northwest China. This marked the completion of the first phase of the construction of the plant which will eventually have a generating capacity of 400,000 to 600,000 kilowatts. The plant will be fueled by coal from a nearby colliery. With its rising metallurgical, machine-building, chemical and petroleum industries, Gansu is planning to further expand its power industry to meet the state's plan of developing the vast northwest. Construction of a 150,000 kilowatt-thermal power and heat plant will begin next year, according to official sources here. [Text] [Beijing XINHUA in English 0721 GMT 29 Nov 84]

GUIXI NO 1 GENERATOR--Nanchang, 21 Nov (XINHUA)--The first generating unit of the Guixi Power Plant in Jiangxi Province, with a generating capacity of 125,000 kilowatts went into operation on 20 November. With a total generating capacity of 500,000 kilowatts, the power project will be completed in 1987. Upon completion, the plant will not only supply power to the Jiangxi copper base, but will also augment the Nanchang power network. [Summary] [Beijing XINHUA Domestic Service in Chinese 1424 GMT 21 Nov 84 OW]

CSO: 4013/49

COAL MINISTER REPORTS IMPROVEMENTS IN INDUSTRY

OW211241 Beijing XINHUA in English 1156 GMT 21 Nov 84

[Text] Tangshan, 21 Nov (XINHUA)--China's coal industry has made all-round improvements in performance this year, according to Vice-Minister of Coal Industry Ye Qing.

In the first 10 months of this year, Ye said, it produced 627 million tons of coal, 37.6 million tons more than planned. The 1984 output is expected to reach 760 million tons, up 6 percent from 1983.

The combined footage of tunneling expected to be completed in mines operating under the ministry this year will be 820,000 meters, 63,800 meters more than planned.

In addition, Ye said, a 7-percent increase is now forecast in the output of washed coal, expected to reach 57 million tons.

Ye Qing released these figures while speaking on Tuesday at the current session of a national coal conference in Tangshan, Hebei Province.

CSO: 4010/32

SHAANXI'S HANCHENG FAST BECOMING COAL BOOM TOWN

Beijing DILI ZHISHI [GEOGRAPHICAL KNOWLEDGE] in Chinese No 9, 7 Sep 84 pp 10, 25

[Excerpts] Situated some 250 kilometers northeast of Xi'an, Hancheng City is Shaanxi's second major coal city. The urban district measures 50.7 kilometers from north to south and 42.2 kilometers from east to west for a total area of 1,869 square kilometers. The population is 290,000.

The Hancheng coal field's northeastern portion is linked to the Hedong coal field just across the Huang He, and the southern portion abuts the Denghe coal region. Prospecting has shown the region to be 60 kilometers long and 15 to 25 kilometers in width for an estimated total area of more than 1,100 square kilometers. In late 1978 the proven reserves were estimated to be 2.77 billion tons, including 400 million tons in the working mines and 810 million tons in mines under construction. General surveys show an additional 270 square kilometers, and the estimated reserves make it even larger than Tongchuan, Shaanxi's biggest coal city, with tremendous potential for exploitation.

The Hancheng mining region has a long history of coal mining: The shallow coal fields have been exploited by hand for hundreds of years. In 1958, the provincial coal bureau, along with local counties and communes, sank a large number of pits. Due to inadequate transportation and shipping capacity, the operations began to shut down one after the other in 1962. After the Xi-Han rail link was opened, work was resumed in 1970 and many more mines were constructed. As of 1977, the mining region's raw coal output was almost 800,000 tons. In late 1979, the Sangshuping coal mine, a state unified distribution mine with an annual output of 3 million tons, was completed. Concurrently, many of the old mines were upgraded and expanded. Today, the Xiangshan mine and the Sangshuping mine, among others, have achieved a rather high level of mechanized operations, and in 1982 one comprehensive mining team at Sangshuping produced 640,000 tons of coal.

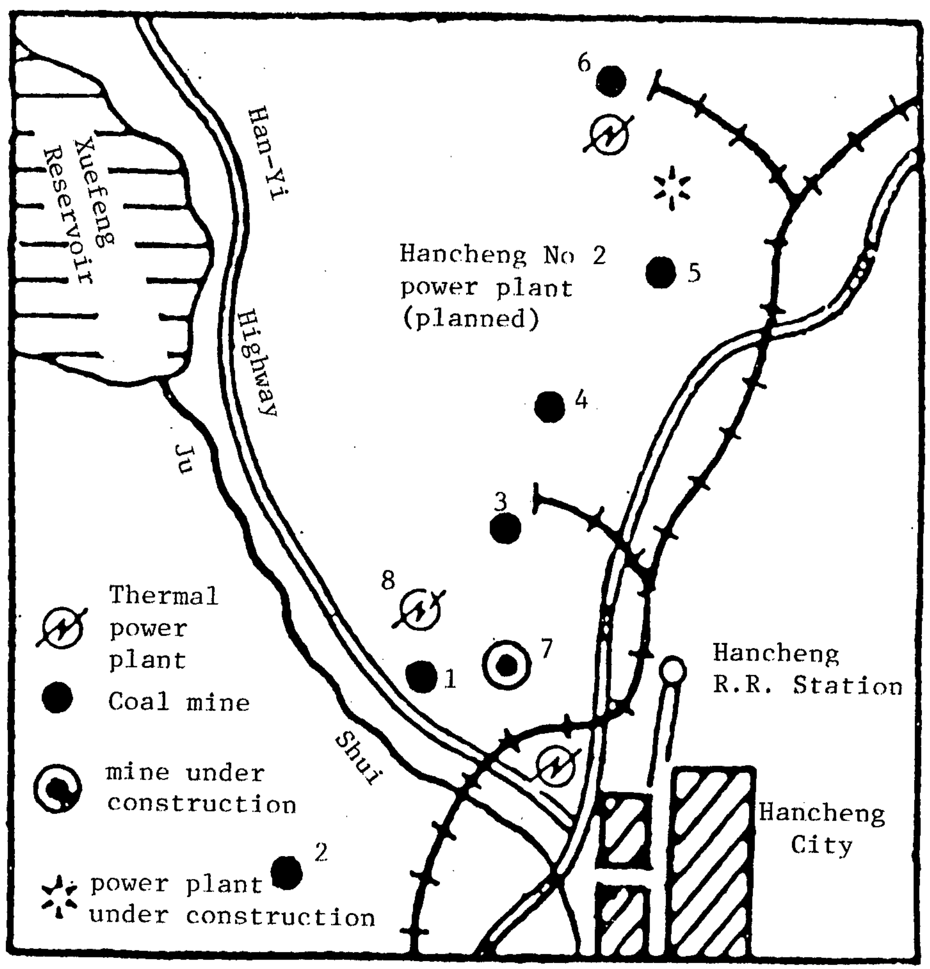
The Hancheng coal fields are divided into a northern and southern part, with the coal having been formed in the Permo-carboniferous period. The Taiyuan Group of the Carboniferous period is found in levels three through nine, with the seams being some 4 to 7 meters thick. Permian period coal is found in layers one through four and the seams are generally 3 to 7 meters thick. The

coal field's hydrology and geology are simple and there is little associated gas. Ranging in order from the shallow to the deeper layers in the northern segment are coking coal, lean coking coal, No 2 lean coal, and No 1 lean coal. Most of the coal in the southern sector is lean coal with meagre coal constituting the bulk of the deposits north of the Ju Shui. Part of the raw coal produced in this region will be for power and steam while the rest would be an excellent raw material for nitrogenous fertilizer or even used for coking coal. The largest enterprise in the coal industry--Hancheng's major industry--is the Hancheng Coal Mining Bureau. Subordinate to this bureau are the Xiangshan, Magouqu, Yingshan, Liaoyuan, Shanggukou, Xiagukou, and Sangshuping mines. The entire mining region now has an annual output capacity of approximately 4 million tons, of which 410,000 tons are mined by the coal enterprises of communes and brigades. Most of the coal produced--except for what is consumed locally--is shipped to consumers throughout the country. In addition to industry in Hancheng, other coal customers include coking coal and nitrogenous fertilizer plants. Also, the region's reserves of limestone, apatite, and magnetite are abundant, accounting for the proliferation of lime, cement, and other building materials industries in the region and small-scale smelters have also been set up. The region's electric power industry has undergone tremendous development. Using the raw coal from the Xiangshan Mine, the Hancheng Power Plant--Shaanxi's second big thermal power facility--is now feeding electricity to Xingping County and the Shaanxi-Gansu-Qinghai grid via a 330KV high-tension transmission line.

Sketch Map of Hancheng Mining Region

Key:

1. Xiangshan
2. Yingshan
3. Magouqu
4. Liaoyuan
5. Xiagukou
6. Sangshuping
7. Yaozhuang (planned)
8. Hancheng Power Plant



CSO: 4013/47

HAIZHOU DRESSING PLANT CAPACITY DOUBLES

Shenyang LIAONING RIBAO in Chinese 30 Aug 84 p 1

/Excerpts: "Equipment of the Fifties Transformed to the Level of the Eighties; This Year 4 Million Tons Enters Dressing Plant Doubling Original Design Capacity; 100 Percent of Washed Coal Meets Standards"/

/Text/ Relying on technological advances, the coal dressing plant at the Haizhou open pit mine in Fuxin has rejuvenated an old enterprise so that the volume of coal entering the plant has reached 4 million tons, doubling the original design capacity with 100 percent of the washed coal meeting standards. The profit turned over between January and July increased 32.7 percent over the same period last year and in terms of output and quality, the plant ranks first among similar enterprises in the nation.

This dressing plant is a specialized water dressing fuel coal chemical industry plant responsible for supplying "feed" for several large heavy industrial enterprises in the province. With the development of the national economy, this plant, which was built in the fifties, was far from being up to the task. Mindful of the general situation, they capitalized on the superiority of their own technological resources and took the road of technological transformation to develop the enterprise. A coal unloading bridge over 100 meters long is the "throat" to the dressing plant. A technological spearhead headed by Engineer Zhang Daochang summarized production practice, carried out studies and converted the original fixed-type "coal turning bridge" into a moving "coal loading bridge" changing a stationary bridge into a moving one and at one stroke nearly doubled the volume of coal unloaded. They were also the fist in the nation to adopt advanced world coal washing technology--new heavy/medium coal washing technology--concluding the history of traditional manual handling of waste rock, finding the key to "intestinal obstruction" in the dressing plant, and blazing a new trail for China's coal dressing industry.

The staff and workers of the Haizhou open-pit mine coal dressing plant drastically transformed and "gutted and rebuilt" the plant's more than 380 pieces of equipment and 9 conveyor belts, adopting new techniques and technology to bring equipment from the fifties up to the level of the eighties so that the old plant would continue to take off, quality improve, and number of varieties increase from the large, medium, and small lumps of coal of the early postliberation period to 42 varieties today, making it one of the largest coal dressing bases in China. Between January and July they also created seven new records, including volume of coal accepted, cost per ton, and ash content. At present, they are tackling 28 new technological transformations to be completed within the year.

8226
CSO: 4013/13

YUNNAN'S COAL INDUSTRY GROWTH 'ENORMOUS'

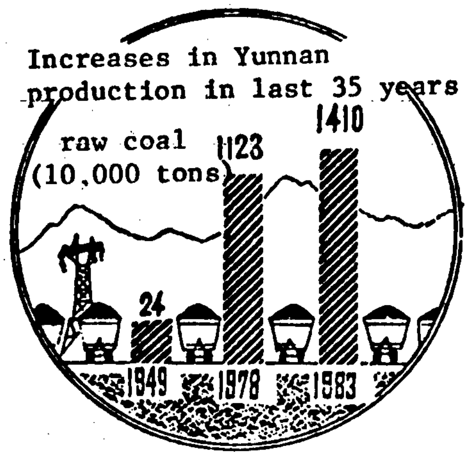
Kunming YUNNAN RIBAO in Chinese 2 Sep 84 p 1

/Article: "Mining Conditions Improve, Production Develops Swiftly"/

/Text/ There have been enormous changes in coal mining in Yunnan: annual output of raw coal has increased rapidly from over 230,000 tons in the early postliberation period to 14.1 million tons last year, an increase of more than 58-fold over 1949. Now, 6 days' production is the equivalent of 1 year's production before liberation. In addition to basically satisfying industrial and agricultural production and the daily, growing demands of domestic life, part of the coal goes to help those outside the province.

According to historical records, beginning in the Ming Dynasty, coal mining was very widespread in Yunnan. Although mining of Yuannan coal has a long history exploitation was very slow. On the eve of liberation there were only three small mines: Mingliang, Yipingliang, and Wuge. Mining tools and equipment were crude and backward and the working conditions were extremely poor. After new China was founded, the party and government made coal mining an important issue and now new modernized mines and small coal pits and local mines cover the entire province and such important links in coal production as extraction, tunnelling, hoisting, drainage, ventilation, and transport are mechanized or semimechanized. Such backward production methods as manual dragging and hauling and horse draft power have now become history. Such large coal mines as Yanchang, Tianba, Laibin, Housuo, and Xiaolongtan have also established special railroad lines and important main line connections so that one-sixth of the province's coal mines can ship directly from the mine by rail to locations far from the source.

At the same time that key coal mines have been established, local and county coal mines and small rural and town coal pits have also developed rapidly. Provincewide, 130 counties and cities have 112 county- and city-run coal mines. There are 72 local and county/state operated coal mines and 3,792 small coal pits. In the first half of this year Yunnan coal production again continued to increase rapidly over the same period last year at a rate of 108.6 percent.



8226
CSO: 4013/13

COAL

XIEQIAO MINE CONSTRUCTION PROGRESSING RAPIDLY

Hefei ANHUI RIBAO in Chinese 8 Sep 84 p 4

[Text] On the north shore of the Huai he, the modernized Xieqiao coal mine is under construction. With a planned annual production capacity of 4 million tons, it is one of the nation's largest mines. The underground coal resource is extremely rich; after construction, 200 railway cars a day will be needed to transport the coal. The mine may be in service for 100 years.

In an area 20-odd kilometers northeast of the ancient tonw of Yingshang, amid a vast acreage of green seedlings, the tall derricks can be seen, and all around them the plant buildings, office buildings, and a never-ending stream of people and vehicles.

By way of introduction, the construction superintendent said the scale of the engineering work is vast. There will be six pits, with galleries running 68,000 meters. Ten or twenty thousand cubic meters of rock and earth must be excavated in digging each pit. He happily related that the pits should be completed within a year of work beginning, in order to cut down on the time delay caused by construction, something virtually unheard of in China. After the pits are dug down to the bottom, they will dig in from the ventilation shafts and out from the main shafts to ensure the galleries are cut out in a way that will greatly reduce overall construction time.

Highways, and power and communication lines were put in first. The refrigeration plant needed for "freeze construction" is already in operation. The first part of the construction proper began at the end of last year. Five thousand construction workers worked hard to ensure the work developed rapidly. They had an auspicious beginning. In the first month of construction of the gangue pit, they set a new record in Huainan for footage of dug in a single month, beating their competition. After the freeze pipes broke, for reasons undiscovered, they pushed aside a host of difficulties to dig down through the casing wall and eliminated the dangerous condition; the construction work went along smoothly. Now the drilling and casing construction work goes on 244 meters below the surface; this means they have dug at an average rate of 44 meters per month, close to the best average in the nation.

As I stood at the mouth of the pit I encountered the morning shift of construction workers, who had just come up from below. They jumped out of the cage and energetically shook their sweat and water soaked clothes.

The auxiliary shaft on the south side of the gangue pit is the closest to completion, next, the main shaft, used for bringing up the coal, will enter the freeze stage. These three pits form a crescent moon shape, and in the middle is the largest refrigeration plant on the frontlines of our nation's coal industry. Two drilling derricks loom up on the east of the mine area, work has begun on the #2 East ventilation shaft using an 8-meter drill imported from West Germany. It has drilled down over 200 meters. Work will begin soon on the No 1 east ventilation shaft. At the opposite end, complex preparatory work goes on for the construction of the western air shafts. In and around the industrial plant area a fever of construction activity goes on to build the secondary plant facilities, administration office building, workers' living and recreation areas, and a cultural-entertainment center. Those at work here strive for timeliness, speed, and efficiency.

The Xieqiao coal mine is located at the south end of the rich Fanxie mine are in the Huainan coal field. Ten years ago the Huainan Coal Mine Construction Directorate and other units involved in construction, together dug the first mine at the east end of the coal field, Fanji No. 1. Fan No 2 and Fan No 3 were built thereafter. As the very large scale Fan No 1 mine with a planned production capacity of 3 million tons is about to go into production this year and the construction is at a high pitch on the other two, the directorate made a strategic leap to the western end of the coal field 100 km distant, reorganized their efforts, and are developing mines on an even greater scale. The startup of construction at Xieqiao has imparted tremendous momentum to the construction activities of the entire Fanji coal field.

12663
CSO: 4013/7

DEVELOPMENTS IN ANHUI'S COAL INDUSTRY OVER PAST 35 YEARS DESCRIBED

Hefei ANHUI RIBAO in Chinese 8 Sep 84 p 4

[Text] Past and Future of Lianghuai Coal Industry

In the 35 years since our nation was founded, new mines have been dug at the rate of 1 every 1 year and 8 months, for a total of 21 new coal mines in the Lianghuai mine area. At the same time the area worked to produce 4.5 hundred million tons of coal, paying in profits some 22.4 hundred million yuan. Especially since the Third Plenary Session of the Eleventh Party Congress, Lianghuai has worked on the basis of the Eleventh Party Congress, Lianghuai has worked on the basis of maintaining safe production and relying on technical improvements, ceaselessly achieving new levels of coal production. The 1983 production of the unified distribution coal mines of Lianghuai reached 22.55 million tons of raw coal, or a 2.3-fold increase over the total produced in 37 years before Liberation.

Before Liberation there were only the three Huainan coal mines in the Lianghuai area. After Liberation, the Party and government on the one hand undertook transformation and expansion of these; on the other hand they built eight large- and medium-scale coal mines one after the other, making Huainan at the end of the 1950's a great mining area with an annual production 1 of 10 million tons. In the Huaibei area, the Zhahe coal field and the Sudong coal field were the target of imperialist ambitions, but never developed. After a period of large scale prospecting and planning, the first mines were dug in late 1958. Three medium and small scale mines were built and started up by the end of 1959, achieving an annual production capacity of a little over 1 million tons in a year's time. There are now 11 developed mines in the Huaibei area. It is a large scale mine area producing over 10 million tons per year. Now the Lianghuai area has been transformed from a single-product coal producing area to a new, large scale comprehensive mine area, complete with the capacities for exploration, planning, mine construction, civil construction, machine building, chemical engineering and the capacity to produce mechanical and electrical equipment as well as building materials.

The Party's proposed target for our nation's people for the end of this century established the strategic position of the development of energy resources, and has placed the Lianghuai mining area in the ranks of the key national construction projects. The Lianghuai mine area is uniquely blessed with developmental superiority. Discovered reserves of 22 billion tons of coal exist, the quality of the coal is good and it is present in a range of varieties. The area lies in the rich land of East China; land and water transport is good. The cadre and workers of the mines are determined to channel this superiority and make a contribution to China's modernization. In the last few years a construction force of 60,000 has been gathered in the Lianghuai area to expand the scope of construction and to speed up the construction of mines. They are determined that by the end of this century there will be altogether 23 new mines, including the 6 giant size and large and medium size mines now being rushed into production, raising the total annual coal production to over 60 million tons, making Lianghuai the energy resource base for East China, East China's Ruhr.

12663
CSO: 4013/7

HUAIBEI'S GROWTH RATE APPROACHING 15 PERCENT ANNUALLY

Hefei ANHUI RIBAO in Chinese 8 Sep 84 p 4

[Text] Intensive development has been tenaciously persevered in over the course of development of Huaibei's coal mines since Liberation. Under the policy similar to the rapid flow of water, coal production has risen dramatically, leaping into the front ranks of the nation's production.

Since the beginning of mine construction 26 years ago, the developers of Huaibei's coal mines have kept their oaths to "Build fast, mine early," and "Produce more coal, make a greater contribution." The Great Leap Forward left some lasting scars on mine construction, but the developers conscientiously implemented revised policies, in large part they completely re-engineered those jury-rigged mines thrown into production in the former period, and held to a course of scientific administration and reforms in excavations. After coal production broke the 5 million ton mark in 1970, on the one hand, they struggled to raise the average unit area yield on coal work faces, and on the other hand, they concentrated their main construction force and gallery design capacity on 10 new work areas with 3.7 million tons of coal. Three new mines were put into operation, so that the raw coal production for the area exceeded 10 million tons by 1976. The Huaibei Mine Bureau's coal production doubled in six years, propelling the bureau into the front ranks of the nation's mine bureaus.

In 26 years of mine construction, Huaibei's coal mine production has increased an average of 14.8 percent per year, a very rapid advance; altogether they have produced 168 million tons of coal, about a 15.5-fold increase over the total produced in 37 years in the Huainan of old. They have turned over to the state profits of over 686 hundred million yuan. Twenty-six years later, the eleven mines in production, excluding the one mine built and put into production last year, all are exceeding their designed capacity; seven of them, including Daihe, Shuoli and Yangzhuang, have doubled theirs.

Today the coal mined from the 70-odd work faces of the 11 coal mines of Huaibei flows out like a long river, day and night, surging in a never ending flow toward Shanghai, Magang, to every province, city and town in East China. In just five and one half years since the Third Plenary Session of the Eleventh Party Congress, they have supplied Anhui with 43 million tons of coal and Shanghai with 6.69 million tons. This has been the contribution of the 100,000 employed in Huaibei's coal mining to the nation's socialist modernization.

Because there is coal underground, we should bring it up quickly, to vigorously develop China and serve in the reconstruction of Anhui. The workers of the Huaibei coal mines are also determined to make this great stream of coal even bigger and to make it flow even faster. They have made their preparations, and will continue to advance from the bases they hold today. They will continue with technological change-overs of old mines, to increase the intensity of the mining. They will enlarge the scale of development of new areas, and accelerate the construction of new mines. They will strive to complete the construction of 11 new mines by 1995, with a designed capacity of 13.8 million tons. Old mines and new pits will advance hand in hand, Huaibei's coal production capacity will double by the end of the century, meeting or beating the 26 million tons mark. By then the Huaibei coal mines will have added to their heroic reputation and dazzling glory.

12663
CSO: 4013/7

COAL

BRIEFS

JIANGSU FULFILLS 1984 STATE PLAN--Jiangsu has fulfilled the 1984 state raw coal production plan ahead of schedule. Over the past few years, all coal industrial departments in the province have made reforms centering around the contracted responsibility system, thus promoting the development of production and construction. As of the end of November, the province had produced 16.24 million tons of raw coal, fulfilling this year's state plan 31 days ahead of schedule. A provincial coal work meeting, which ended in Yangzhou on 9 December, analyzed the present situation in Jiangsu's coal industry and proposed the guiding principle for developing Jiangsu's coal industry. At the meeting, provincial Vice Governor Chen Huanyou encouraged all departments to make still greater contributions to mitigating contradictions in coal supply in Jiangsu and developing Jiangsu's industrial and agricultural production. [Excerpts] [Nanjing Jiangsu Provincial Service in Mandarin 1100 GMT 9 Dec 84]

SHANXI OVERFULFILLS PLAN--Taiyuan, 7 Dec (XINHUA)--Shanxi Province, which produces more than one-fifth of China's coal, has overfulfilled its annual coal production plan 1 month ahead of schedule. According to statistics, the province produced 160 million tons of coal from January to November this year, 11 million tons more than was set by the state plan. It is predicted that coal production for the entire year will exceed 170 million tons, some 17 million tons more than in the previous year. This is the highest growth rate in recent years. [Text] [Beijing XINHUA Domestic Service in Chinese 1415 GMT 7 Dec 84 OW]

SHANDONG COAL PIER COMPLETED--Jinan, 6 Dec (XINHUA)--Construction of a large coal pier in Shijiu Port, Shandong, was completed in late November, 1 month ahead of schedule. The pier, a key state project and the largest of its kind in the country for coal transportation, has two deep-water berths for 100,000-ton vessels. It has a designed handling capacity of 15 million metric tons of coal annually. The construction of the pier, which is 1,874 meters long and 36 meters wide, involved the construction and sinking of 32 caissons each weighing from 1,600-2,733 metric tons, the construction of 13 large steel beams, the pouring of over 123,000 cubic meters of concrete, and the dumping of over 490,000 cubic meters of rocks in the sea. [Summary] [Beijing XINHUA Domestic Service in Chinese 0946 GMT 6 Dec 84 OW]

TAIYUAN COAL GASIFICATION PROJECT--Taiyuan, 2 Dec (XINHUA)--With the commencement of operation of the Taiyuan Coal Gasification Corporation's new coking and gas project today, the 600,000 people of Taiyuan city will be able to use coal gas before the coming New Year's Day. Wang Zhen, member of the Political Bureau of the CPC Central Committee, cut the ribbon at a ceremony marking the commencement of this project's operation. The Taiyuan Coal Gasification Corporation is the first large complex for multi-purpose utilization of coal in our country, with joint investment by the Ministry of Coal Industry and Shanxi Province. The coking and gas project, which went into operation today, consists of a coking plant and gas pipelines totaling 120 km in length. This is part of the corporation's first-stage construction program. The entire program is expected to be completed before 1988. [Text] [Beijing XINHUA Domestic Service in Chinese 1239 GMT 2 Dec 84]

LIAONING LOCAL COLLIERIES--Liaoning Province's local collieries prefulfilled their annual production target by 46 days. As of 15 November, these collieries had produced 6.3 million tons of raw coal, an 18-percent increase over the corresponding period in 1983. So far, the number of town- and township-run small collieries has increased to 630 from less than 400 in the last year, and their annual production capacity has reached 7 million tons. [Excerpts] [Shenyang Liaoning Provincial Service in Mandarin 1030 GMT 16 Nov 84 SK]

NEW SHANXI MINE—Taiyuan, 6 Dec (XINHUA)--Construction work began in Shanxi Province today on a coal mine which will produce 4.5 million tons a year. Shanxi is China's leading coal producing province, providing more than one-fifth of the nation's output. The Sitaigou mine is part of the Datong coal field in Northern Shanxi, which is expected to produce more than 28 million tons this year. Construction of the new mine, which will cost 450 million yuan, is one of the steps being taken by the Datong Mining Administration to boost annual output to 50 million tons by the end of this century, said official sources here. It will be completed in December 1991. Construction of another new mine is in full swing in Datong and will be finished in 1987. The Yanzishan mine is designed to produce 4 million tons a year. [Text] [Beijing XINHUA in English 1447 GMT 6 Dec 84 OW]

CSO: 4010/40

BIDDING ON OFFSHORE OIL AREAS OPENS

OW211009 Beijing XINHUA in English 0907 GMT 21 Nov 84

[Text] Beijing, 21 Nov (XINHUA)--China will open bidding tomorrow on 100,000 square kilometers of joint offshore oil exploration areas, the China National Offshore Oil Corporation (CNOOC) announced here today.

The first four blocks to be offered will cover 13,300 square km in the eastern part of the Yinggehai Basin, in the South China Sea south of Hainan Island. Areas in the Pearl River Mouth Basin and the southern and northern parts of the southern Yellow Sea will be offered later.

There was "good oil and gas potential" in the Yingge Sea basin blocks, said CNOOC spokesman Chen Bingqian. Gas fields with impressive reserves had already been found in one block in the basin operated by the Atlantic Richfield Company (ARCO), he added.

The new round of bidding is the second held by China so far. During the last 4 years, including the first round in 1982 and 1983, CNOOC signed 23 contracts on 93,289 square km of offshore areas. Foreign oil companies would invest a total of more than 2 billion U.S. dollars under these contracts, Chen said.

Bidding would proceed in steps and CNOOC would issue its No 1 notification tomorrow about the specific bidding procedures for the eastern part of the Yinggehai Basin.

Lying more than 20 km south of Hainan Island, this part is less than 200 meters deep in most cases. There were dozens of geological structures for exploration, he added.

He said that the second round of bidding would be done without any restrictions. Foreign firms participating or not in the first round would be welcome to offer bids. CNOOC would treat all bidders on an equal footing and select the most competitive ones.

The basic terms of contracts would remain the same as those in the first round. Foreign partners would bear the risks during the exploration period, CNOOC had the right to participate in funding during the development period and the two parties would share the profits according to the provisions of their contracts.

On the basis of equality, mutual benefit and trust, Chen said, CNOOC would take more flexible approaches to ensure foreign companies' economic returns.

The deadline for applying to purchase data about the eastern part of the Yinggehai Basin is 18:00 hours Beijing time, 15 December 1984.

Up till now, Chen said, foreign partners in the first round had shot more than 200,000 km of seismic line, discovered some 700 structures, and sunk 59 exploratory wells. Twenty-seven wells had reported oil and gas flows with some producing a daily average of more than 1,000 tons according to production tests.

The first offshore oilfield in the South China Sea was expected to start operations in mid-1986, he said.

At present, 13 drilling vessels are operating in the Bohai Sea, the southern Yellow Sea and the South China Sea with some 1,000 foreign oil technicians and specialists working alongside their Chinese colleagues.

CSO: 4010/32

SICHUAN NOW PRODUCING NEARLY HALF OF NATION'S NATURAL GAS

Chengdu SICHUAN RIBAO in Chinese 22 Sep 84 p 1

/Excerpt: "Keeping Up the Spirit of Building an Enterprise Through Hard Work, Relying on Scientific and Technological Advances; Sichuan Becomes China's Largest Base for Natural Gas"/

/Text/ Since the founding of the PRC, Sichuan's petroleum and natural gas industry has developed rapidly. By the end of 1983, the cumulative total of natural gas produced was 78.4 billion m^3, and Sichuan's natural gas output is now 44 percent of China's total natural gas production, putting us in first place. Three days' production of natural gas is equivalent to 13 years of gas production for the province before liberation.

Sichuan has abundant natural gas resources and was the first area in the nation to develop and utilize natural gas. However, it wasn't until 1963 that Sichuan began exploitation for petroleum and natural gas. At the time there were only two old drilling rigs, and some 200 petroleum workers. There was constantly a shortage of drilling and prospecting equipment so drilling was intermittent. Thirteen years before the founding of the PRC, the Sichuan had drilled only 5½ wells, and found 2 gas wells, with a cumulative gas production of only 30 million plus m^3. The natural gas industry was on its last legs.

After new China was founded, the party and government paid considerable attention to the development of Sichuan's petroleum and natural gas industry, technology and equipment was constantly renewed, production scale constantly expanded. By 1983, the Sichuan Petroleum Management Bureau had nearly 90,000 employees and over 100 drilling rigs, ahd drilled 2,342 wells on the 169 structures in the 190,000 km^2 of the Sichuan Basin. They discovered 62 gas fields, 12 oil fields, put over 700 oil and gas wells into production, built over 2,300 km of natural gas long-distance pipelines and collector trunk lines, and had formed a semi-ring-shaped gas pipeline beginning at Dazhu in the east and cutting across Longhe to connect Chongqing, Luzhou, Zigong, Chengdu, Deyang, and stretching north to Mianyang and Jiangyou to supply gas as a raw material and as fuel to 400 enterprises in 14 localities and cities of Sichuan, Yunnan, and Guizhou. Annual production of natural gas can increase to 5.2 billion m^3 making this the largest natural gas production base in the country.

Natural gas occupies an important place in the economic development of Sichuan. It not only supplies
Chemicals, Lutian Chemicals, Chitian Chemicals, Yuntian Chemicals, Sichuan Synthetics, Chongqing Steel, and Chang Steel and nearly 70 small chemical fertilizer plants, but is also used for producing many chemical products such as carbon black and sulphur, and plays an important role in the development of Sichuan's chemical industry, light industry, metallurgy, electric power, machine building, and military industry production. Now, Sichuan's natural gas carbon black makes up one-half the total national production and the quality of sulphur is the best in the nation.

With advances in science and technology, the level of Sichuan's natural gas exploration and development technology has clearly improved. Petroleum staff and workers have not only explored and summarized from practice well distribution methods, drilling techniques and development technology for dealing with Sichuan's complex stratigraphy and solid rock, but also have actively introduced foreign advanced equipment and promoted new technology and new techniques to promote the rapid development of Sichuan's petroleum and natural gas industry. The number of feet drilled in 7 days drilling now exceeds the total number of feet drilled in 14 preliberation years. We are in first place nationally in 10 industrial technology areas such as drilling extra-deep wells, ultra-high-pressure gas wells, and sloped wells.

At present, with the impetus of the entire Party and reform, the Sichuan Petroleum Management Bureau has developed and formally established a master plan for doubling the output of Sichuan's natural gas reserves in 1990. Exploration and design work has already begun on the northern gas trunkline which will go from Quxian in northeast Sichuan through Suining in central Sichuan to Chengdu.

8226
CSO: 4013/13

SHENGLI OILFIELDS TOP 20 MILLION TONS IN OUTPUT

SK220548 Jinan Shandong Provincial Service in Mandarin 2300 GMT 21 Nov 84

[Excerpts] By 0800 on 21 November, the Shengli oilfield topped 20 million tons in its crude oil output, an increase of 3.78 million tons over the corresponding period last year, and a record high in its annual crude oil output and its annual increased output over the past 20 years since the opening of the oilfield.

Last February and April, Hu Yaobang, secretary general of the CPC Central Committee, and Zhao Ziyang, premier of the State Council, made an inspection tour of the Shengli oilfield one after the other, and expressed their hopes that the Shengli oilfield will soon become the second Daqing and will provide timely help for national economic construction. The vast numbers of workers and staff members of the oilfield were greatly inspired, and all fronts were full of vigor, thus accelerating the pace of production and construction.

Since the beginning of this year, the prospective front has made important breakthroughs, has opened up many new areas with high yields and good development prospects, and has sunk in at different areas 10 especially big high-yield oil and gas wells with a daily output of 1,000 tons and a number of 100-ton wells. So far this year, 607 new wells have gone into production, and a total of 2.92 million more tons of crude oil have been produced.

At present, the daily output of crude oil is 20,000 tons more than that at the beginning of this year. To top 20 million tons in the annual crude oil output was the oilfield's desire 8 years ago. In 1978, the past record year, the annual crude oil output had reached 19.4 million tons. After this, the oil output declined for 3 years in a row. As of 1981, the annual crude oil output declined to 16.1 million tons. Through the efforts in the past few years, especially thanks to the hard work of the large number of workers and staff members since the beginning of this year, the Shengli oilfield has finally realized its long-cherished wish, and prefulfilled by 40 days the goal of topping 20 million tons in the annual crude oil output.

CSO: 4013/38

DEEP RIFTS AND BASEMENT SEAMS: RETHINKING LONG-RANGE OIL AND GAS FORECASTS

Beijing ZHONGGUO DIZHI [CHINA GEOLOGY] in Chinese No 4, 13 Apr 84 pp 14-17, 13

[Article by Zhu Ying [2612 5391]]

[Text] The work of oil and gas surveying and prospecting has been developing continuously over the 30 years since liberation, and all basins in continental China which could harbor oil and gas have already been preliminarily explored. All oil fields which could be discovered with relative ease have already been found, and the degree of difficulty in finding new oil and gas fields has been growing steadily. Therefore the problem of how to find new oil and gas fields and provide a useable oil and gas reserve for China's four modernizations is an important task for current work in petroleum geology.

1. The function of deep rifts in the formation and accumulation of oil and gas has not yet attracted the attention it warrants in China. One reason for this is that rifts, especially deep rifts, are often considered unfavorable to or disruptive of oil and gas pool formation and persistence (in fact, rifts are involved in many formations composed of superimposed sedimentary rock; the existence of a deep rift zone often is an indispensable condition for the migration of oil and gas, especially vertical migration across strata). Another reason has to do with the theory of the organic origin of petroleum.

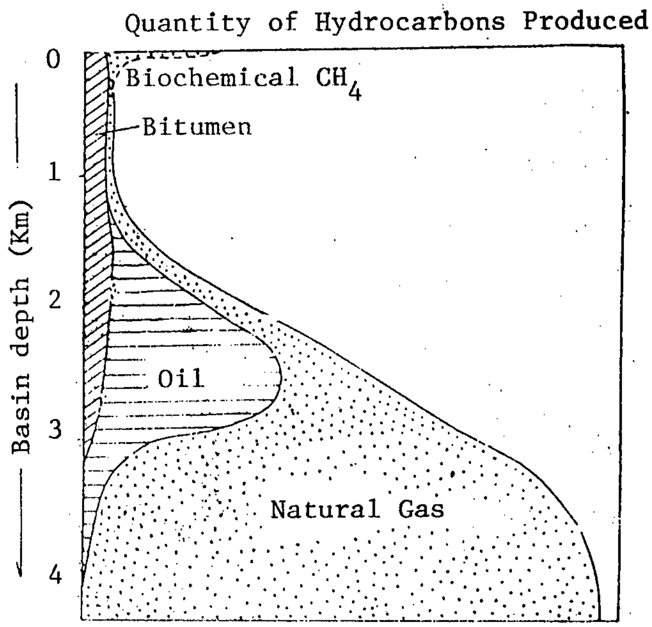
According to the theory of organic origin, petroleum is formed by prolonged incubation of plankton. However, a number of questions are not yet satisfactorily resolved: Where are the traces of the incubation site? What is the nature of the incubation process? What are the intermediate products of the process? After the oil and gas are produced, by what route do they reach their present accumulation site? If we also consider the formation of natural gas, then the matter becomes even more complicated. For these reasons, the theory of inorganic origin has been proposed.

Since the principles of plate tectonics became known, the theory of inorganic origin has been further developed. It is thought that deep-origin hydrocarbons may act as some kind of intermediary or catalytic agent. Therefore, in some active zones of the earth's crust (such as oceanic trenches and diminution zones) advantageous temperature and pressure conditions have produced oil pools of considerate size. For example, an oil field of commercial value has been found in the Red Sea rift valley, an exploitable oil field is located in the Rhine graben, and the Los Angeles oil field in America evolved in the vicinity of a mid-oceanic ridge faulting zone.

Figure 1 shows that natural gas is considerably more abundant than petroleum of depth. If petroleum and natural gas have both common and different origins, then this fact must not be ignored.

Figure 1. Relationship between quantity of petroleum and natural gas formed and basin depth.

(After B. Tissot)



In recent years a number of domestic and foreign research reports have made it clear that the status of geothermal fields during the formation, migration and accumulation of petroleum is attracting increasing attention. It should be pointed out that the distribution of continental geothermal fields is closely related to activated states of the upper section of the earth's crust and to late-period igneous activity, and that all of these are inseparable from crustal faults and deep rifts and from neotectonic movements. Therefore, no matter whether oil derives from organic matter or from deep-seated inorganic sources, serious attention should be given to deep rifts.

2. Deep rifts (i.e., crustal rifts) have a long developmental history and have long controlled the formation and development of continents. As a rule these rifts cut through the entire crust rather than only through the upper part of the crust or the sial layer.

However, not all crustal rifts found in China's major oil and gas basins are of this character.

We will now discuss only those crustal rifts which are connected with oil and gas reserves.

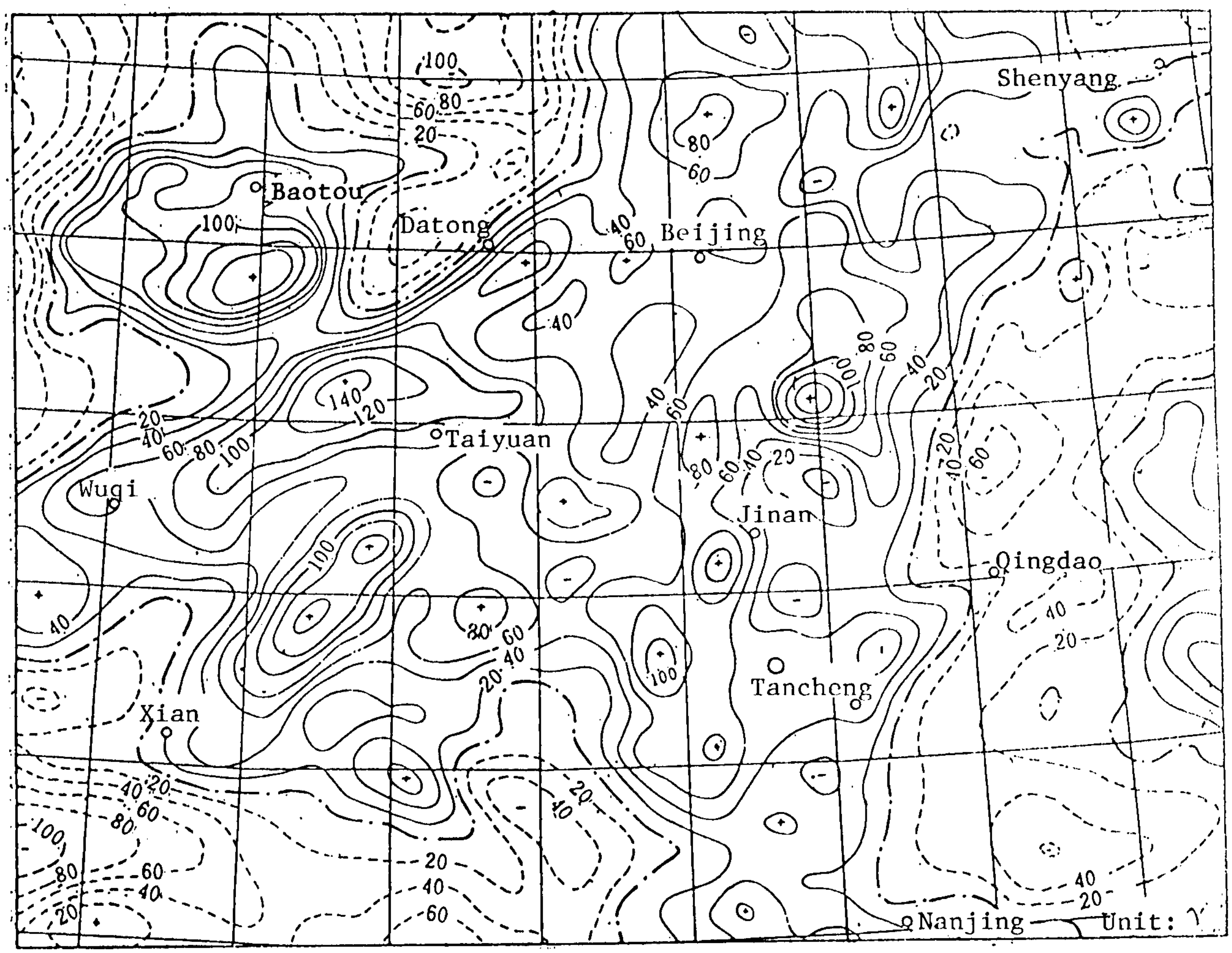
The first type is the deep rift related to the formation of rift valley-type graben sedimentary depressions.

The Tanlu deep rift appears in central Shandong Province exclusively in the form of a rift valley graben; the Laizhouwan graben is its northward extension.

In the reduction-to-pole upward continuation mop (based on 40-kilometer profiles) shown in Figure 2, this deep rift appears as the eastern edge of a magnetic block. This feature extends along the east coast of the Bohai to near Liaoyang. Therefore, the large rift structure on the east coast of the Bohai should be regarded as an extension of the Tanlu deep rift. However, since the Palaeozoic Era, this rift has become a highly active seam as a result of neotectonic movement; the Bohai earthquake (1975) occurred along it.

Another situation which is extremely similar to this is the south section of the Longjiang-Shuangliao deep rift, i.e. the Baokang rift, which forms the western boundary of the Songliao depression. The western part of the Changling downwarp zone, which is east of the Longjiang-Shuangliao deep rift, is situated near a deep downwarp which runs in a neatly north-south direction. It is similar in nature to the Liaodongwan graben and was formed over a deep rift of pre-Palaeozoic age. Therefore, in our opinion, its oil prospects too should be evaluated from this point of view.

Figure 2. Reduction-to-pole upward continuation contour map (40-kilometer profile) based on aeromagnetic survey of North China.

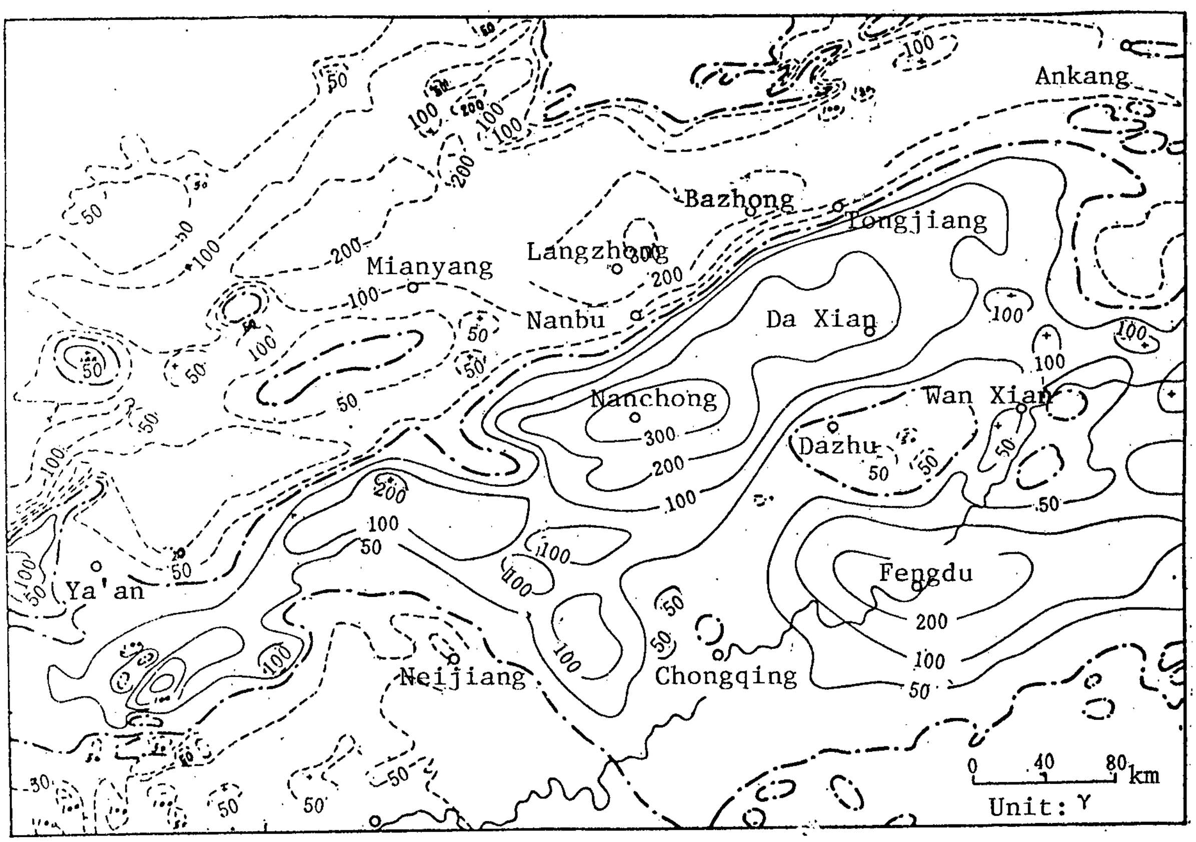


The second type of deep rift derives from a less intense type of neotectonic movement. Because these rifts are deeply buried and are situated in the center of large gas and oil basins, their significance has long escaped notice.

In the central Ordos Basin occurs a very obvious linear boundary of a magnetic block, running northeastward: The Datong-Wuqi deep rift zone (Graph 2), which has the same characteristics as the Tanlu Nu deep rift. However, west of the Huanghe, this zone has all been deeply buried under an old platform. It has shown no obvious recent activity. It is actually a basement seam.

Similar basement seams also exist in the ancient basement of the Sichuan Basin. From Figure 3, we can see that from Tongjiang through Nanbu to Ya'an there is a linear boundary separating magnetic fields with obviously different characteristics. Although the ancient magnetic block is very deeply buried, the gradient zone on its northwestern edge is particularly evident, reflecting an abrupt change in the tectonic environment. We thus think it has the depositional environment and deposition characteristics that are unique to the Longmenshan piedmont depression and may run southeastward, stopping near the deep rift in the south. We suggest that this supposition be used to reconsider the evaluation of the oil and gas prospects north of the Sichuan Basin.

Figure 3. Aerial magnetic survey isoline map of Sichuan Basin



3. A variety of situations result when a crustal rift is combined with an oil-gas basin. The huge positive magnetic anomaly zone distribution along Liaodongwan and Laizhouwan bays was largely formed during the period of most intense activity of the Tanlu deep rift (1.8-2.0 billion years ago). However, by the later periods of platform formation, only its east edge, particularly north of Longkou, showed intense neotectonic movement. Therefore, we lump the lower Liaohe-Liaodongwan graben and Laizhouwan graben together and regard them as rift-valley grabens.

In this graben zone, the physical fields from the deep structure are still in evidence. This is a typical oil and gas accumulation site in the fault-depression zone of a crustal rift. Even though the oil bearing rock series is not very thick, the existence of these advantageous deep-seated conditions could clearly have enriched the oil and gas content. For this reason we emphasize prospecting for oil and gas in this area.

The deep rift along the eastern edge of the Bohai is located on the eastern edge of an ancient complex zone (positive magnetic anomaly), while the Baokang rift is located along its western edge. They both are of similar marginal nature and both plunge towards the west. The difference between the two is that the former is primarily a normal fault type and the latter is a reverse fault type. As over this section of the Longkou-Shuangliao deep rift, the ancient remelted complex constitutes the Changling high magnetic intensity zone which runs north to south. Therefore, the Changling downwarp can also be regarded as a rift-valley graben; it is actually a recent graben which formed in the ancient rift valley.

What makes the Datong-Wuqi deep rift different from those discussed previously is that it is situated in the center of the Ordos Basin. The sedimentary rocks on both sides of it are thick and deeply buried underground. Therefore, this zone itself greatly merits attention. In addition, on the northwest side of the Datong-Wuqi deep rift occur two relatively high magnetic intensity zones which are largely parallel to each other. Judging from the continuance of the structure of the sedimentary rock in the platform basin, these relatively high magnetic intensity zones which are situation on the three marginal areas, are the signs of large-scale subsequent arch upwarping.

In addition, near Wuqi and Huanxian, there are three rather local zones of high magnetic intensity which are reflections of relatively solid rock bodies in the basement complex system (Figure 4). Because of its extensive remelting and crystallization, its physical nature is different from that of the rocks around it. The weathering and enudation of its surface is also different. In these areas there are always favorable locations for the development of subsequent dome-shaped upwarping.

Even though the crustal structure of Bachu Basin is different from that of North China and Manchuria and the apparent forms of their crustal rifts are also different, if we compare Figure 2 with Figure 3, we discover that not only are these similarities between the characterisitcs of the north section of the Tanlu rift and of the southern seam, they are of the same nature. Because of the great depth of burial of the basement rock Bachu Basin, we still

cannot describe in detail the situation of the southern seam as it relates to the basement lithofacies structure. Nevertheless, the existence of the southern seam is beyond question, and it is suitably reflected in the characteristics of the surface features.

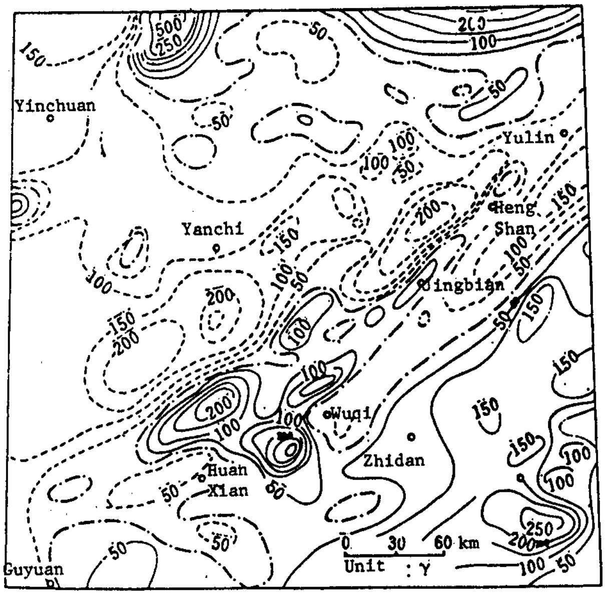


Figure 4. Magnetic field in Ordos Basin

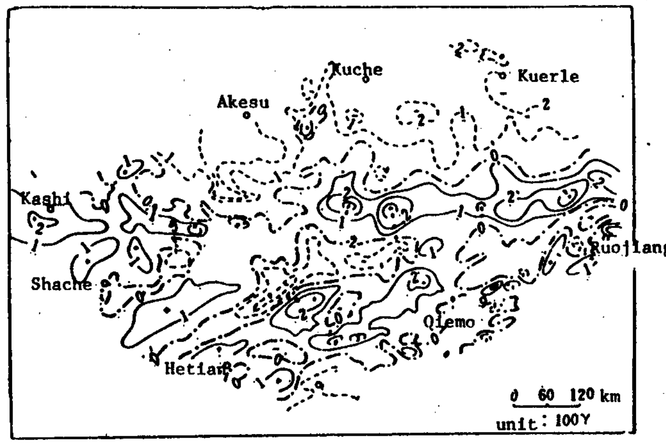


Figure 5. Δ T map of Tarim Basin, from aeromagnetic survey

It must be pointed out that this kind of weak zone existing within the basement is a favorable location for relaxation of stresses deriving from late differential block-faulting and that movement; flexures and folds will form in the overlying sedimentary strata, both sides, leading to the formation of deep-seated oil accumulations. The existence of the basement seams causes the permeability of the central part of the overlying bed to rise and the thermal flux to increase; thus it is more beneficial for oil and gas formation and migration. Therefore, the situation is very advantageous, in terms of either an organic or a deep-seated inorganic origin of petroleum.

4. From Figure 5 we can see that to the north of Ruojiang there is a huge fully formed high magnetic intensity zone which runs northwestward; it continues on toward the east for more than 700 kilometers. The situation in the west is slightly different, but its features can be traced. This positive magnetic anomaly zone is the relection of a huge structural magma complex zone, and is a sign of the existence of a deep rift. Based on the obvious differences between the deep background deep magnetic fields on the two sides, we may conclude that the influence of the Caledonian-Hercynian orogenic movement north of the Tianshan may not have extended past this line.

In addition, the deepest part of the eastern Tarim depression is situated just on this positive magnetic anomaly. Therefore, in our opinion, after the formation of the Tarim platform, it existed for a time in the form of a rift-valley graben. Very possibly a platform-shaped Hercynian foredeep once existed on the north of this deep fault. On the other hand, the Kuche piedmont depression of the Mesozoic Era is relatively limited in extent.

The Jurassic system of the Kuche piedmont depression is oil-bearing, and the Yiqikelike oil field is located on the south edge of the Tianshan. In our opinion, in order to create a new situation for oil and gas prospecting in the Tarim-Basin, we should begin by investigating the oil content of the Mesozoic series and the conditions in the Paleozoic series.

In terms of the relationship between deep rifts and oil reservoirs, the area along a line from Kashi to Ruojiang and places slightly to the north can easily produce breakthroughs. In terms of the overall geological environment, the rift-valley grabens in the area have been sinking, and since the Upper Paleozoic Era, this sinking tendency has moved northward. Further, it can be seen from Figure 5 that the northern edge of the positive magnetic anomaly zone which runs east to west is not straight. This indicates that, on the one hand, the northern fault of the deep rift probably dips northward while, on the other hand, Hercynian igneous activity may have occurred. All these conditions are beneficial for cap roch development and for gas and oil formation and migration. If depression oil fields can occur to the north of the northern fault of the central deep rift zone, then fields to the south of the southern fault may possibly be of the platform type.

Other oil and gas prospects in the Tarim Basin, e.g., that the southwest depression zone is also a promising area, that there is extensive rifting on the high part of the Bachu upwarp which suggests that we should search for Paleozoic natural gas, and that coal gas in the Qiemo block-faulting zone merits attention, are outside the scope of this article and will not be discussed.

12,668
CSO: 4013/153

OIL AND GAS

BRIEFS

TIANJIN TEST WELL--Tianjin, 7 Dec (XINHUA)--A test well sunk recently at Liaodong Bay, Northeast China, is producing a daily average of 530,000 cubic meters of natural gas and 226 cubic meters of oil condensate. The Tianjin-based Bohai Sea Petroleum Company announced today that the well, sunk by its No 7 drilling rig, promised good offshore reserves. [Text] [Beijing XINHUA in English 1604 GMT 7 Dec 84 OW]

NEW XINJIANG OILFIELD-- Urumqi, 15 Nov (XINHUA)--Development and construction of a new oilfield--Kokyar Oilfield--have begun in Xinjiang. A petrochemical complex which includes a refinery, a chemical fertilizer plant, a liquefied petroleum gas plant, and a thermal power plant which utilize petroleum as their major raw material will be built here. Currently, oil extraction equipment, oil pipelines, oil stations and other facilities are either under construction or on the designing board. Kokyar oilfield was discovered in 1977. Prospecting in the past 7 years has revealed the growth of oil-bearing strata and rows of oil deposit structures and verified some figures of the oil-bearing area and reserves. Prospecting of petroleum gas is still under way. More oil reserves are expected to be discovered. [Excerpts] [Song Zhenghou] [Beijing XINHUA Domestic Service in Chinese 0038 GMT 15 Nov 84 OW]

CSO: 4013/38

NUCLEAR POWER

ECONOMICS OF PWR AND HWR REACTORS COMPARED

Chengdu HE DONGLI GONGCHENG [NUCLEAR POWER ENGINEERING] in Chinese Vol 5 No 4, Aug 84 pp 34-40

[Article by Luo Anren [5012 1344 0088]: "An Economical Comparison of PWR and HWR Nuclear Power Stations in China"]

[Text] Abstract

The choice of nuclear power stations in China--the pressurized-water reactor versus the heavy water reactor--was a major technological policy issue, which has now been mostly resolved. This article, written in mid-1982, gives the data, criteria, calculation method and results used by the author in an economical analysis of the two types of nuclear power stations. The author concluded that pressurized-water reactors are more suitable for China.

I. Introduction

Up to mid-1982, there were three different views held by China's nuclear workers on the economy of the pressurized-water reactor (PWR) and the heavy water reactor (HWR). The first view believes that when nuclear power stations are imported under a combination of technology import and trade, the Canadian tubular natural uranium heavy water reactor is economically superior to pressurized-water reactors since the HWR has a lower cost for power production and therefore a higher profit. The second school of thought believes that, reactor for reactor, the HWR is more economical than the PWR but not by very much; in terms of serial systems the PWR is somewhat better, but not by a lot. The greater the scope of nuclear power, the better it is to develop the PWR. The author belongs to the third school of thought, that is, the HWR does not have particular economic advantages over the PWR and the choice in China should be determined mainly by the industrial base and the research level; these factors favor the choice of the PWR.

To the author's knowledge, there have been writings on each of the three opinions. The calculation methods used in these articles are the same and the key to the different conclusions is in the original data and the comparison criteria used. In the author's opinion, the main economic indicator in the

comparison should be the investment efficiency. In the Soviet Union, this is known as the standard coefficient for investment efficiency and some authors use the power production cost as the principal indicator. In order to unify the opinions, one must use unified raw data and criteria. If a consensus can be reached regarding the original data and the comparison criteria and if the method of analysis and calculation are the same, then the conclusion will automatically be consistent. Therefore, this article will emphasize a discussion on the original data and the criteria for comparison and introduce the calculation method. Finally, the calculation results and conclusions will be presented.

II. Choice of the Original Data

To assess the economic efficiency of an engineering project, one must first know the capital investment and the production cost, and the investment utilization coefficient as well. In the case of a nuclear power station, one must know the price of the fuel and the heavy water in determining the capital investment and the power station capacity, consumption of the nuclear fuel, the thermal efficiency and the power consumption of the station to determine the cost for producing electricity. For the convenience of calculation, we choose 0.9-1 million kilowatt gross power single reactor stations as our objects of study. Table 1 shows the technical and economic parameters used by different authors for reactors of this power. As can be seen, with the exception of the capacity factor, there are innegligible differences. The values of some other useful parameters were not given in the references. It is, therefore, necessary to discuss the selection of parameter values one by one.

1. Specific investment of the power station

The specific investment figures quoted in articles of the opinion I and opinion II are based on data before 1980 and do not appear to have taken the price adjustment factor in China fully into account. Up to now, China has not had the experience of building a large nuclear power station, therefore,unlike America, we cannot draw on two decades of experience of building dozens of nuclear power stations. In estimating the building costs, we do not have detailed time dependent material and labor costs to do a computer analysis with thousands of inputs. We can only make a rough estimate based on the design and construction costs of medium and small nuclear power stations in China and the cost for building nuclear power plants in foreign countries. The specific investment figures used by the author in Table 1 are the estimated results after consultations with the departments in charge and are based on the premise of building a series of power stations after mastering the technology of building large nuclear power plants. Because they are based on a wider consultation and more recent data, they are more likely to be realistic. But because of the lack of experience and the once rapidly changing price in recent years, it is hard to estimate the future change of this parameter. We assume that the change in price is small. Hence, the values listed in Table 1 cannot be absolutely accurate and the likelihood for under estimate is greater. However, in this study, wer are interested in the relative value rather than the absolute value and inaccuracies in the absolute value do not change the conclusions.

Table 1. Technical and Economic Data of 1 Million Kilowatt (gross electrical power) PWR and HWR Reactors Used by Various Authors

Reactor Type	Parameter	This work	Opinion II	Opinion I
PWR	Specific investment (including fuel), yuan/kW	1,375	1,167	1,080
	Fuel consumption, MW.day/ton	38,000	33,000	33,000
	Thermal efficiency, %	33.8	32.5	
	Capacity factor, %	70	70	70
	Electric power usage, %	5		
	Specific investment (including heavy water), yuan/kW	1,700	1,420	
HWR	Fuel consumption, MW.day/ton	7,000	7,500	7,000
	Thermal efficiency, %	28.4	29.1	
	Capacity factor, %	75	75	75
	Electric power usage, %	6.5		

2. Nuclear fuel consumption

The average consumption of large PWR stations designed in the early 1970's is about 33,000 MW.day/ton and a few are above 35,000 MW.day/ton. Experience[1,2] shows that the average consumption often exceeds the design value considerably and some have reached 45,000 MW.day/ton. Recently many countries have improved the fuel burnup and are in the process of developing components for 50,000-55,000 MW.day/ton and expect to succeed in the mid-1980's. In the late 1970's the Westinghouse Company and other companies had promised the users in providing 36,000 MW.day/ton components[3] and the figure has recently been raised to 38,000 MW.day/ton. Therefore, in our analysis we take 38,000 MW.day/ton as the average value.

In the area of the HWR, Canada is currently building its newest Darlington single reactor power station with a power rating of 935,000 kW and expects to complete the first reactor in the late 1980's; its design burnup rate is 7,000 MW.day/ton. We take this number to be the representative rate for the HWR.

3. Thermal efficiency and electric power usage

The net thermal efficiency of million kilowatt size PWR stations is generally between 32.5 and 34.5 percent; we use 33.8 percent as the average. Regarding the choice of the technical and economic parameters for HWR and PWR stations, Westinghouse and the Canadian Atomic Energy Company have made a number of

analyses and many differences in opinion remained. However, the Canadian Atomic Energy Company did not challenge the claim made by Westinghouse that the thermal efficiency of the 620,000 kW Canadian HWR station is 28.4 percent. Since we found some discrepancies in the thermal efficiency data of the Darlington HWR power station, we shall use the thermal efficiency of the 620,000 kW standard HWR station as a representative value.

In this article the power of the reactor station is based on the raw power, a correction must be made for the electrical energy usage by the power plant in computing the power production cost. The power usage rate of 1 million kW PWR stations is between 4 and 5 percent, we use 5 percent. For large HWR stations, the plant power consumption is 6.25 to 6.75 percent, we use the average value of 6.5 percent.

4. Capacity factor

In choosing the capacity factor for a nuclear power plant, we refer to the value used by foreign countries in their economic analysis of nuclear power stations and we also consider the actually achieved capacity factor and the expected value in the near future. In 1979, South Korea bought two 940,000 kW PWR nuclear stations from Westinghouse and the anticipated capacity for the third year to the tenth year is 80 percent. The International Atomic Energy Organization recommended 75 percent in the book "Economic Evaluation of Nuclear Power Stations." The official design criteria in France is that the capacity factor is 50 percent during the first year, 60 percent during the second and third years and 70 percent in the fourth year and afterwards. In China, the Taiwan Province uses 65 percent.[6] So far we have not seen values lower than 65 percent used in the economic analysis of nuclear power stations in foreign countries.

In 1981 we have analyzed the actual capacity factor of PWR power stations in the world. The U.S. PWR stations have a capacity factor greater than 73 percent after the seventh year of operation and the cumulative capacity factor of 690,000 kW to 990,000 kW PWR reactors is 63 percent. Recent French data show that up to 1 Janaury 1982, all 19 900,000 kw PWR stations in operation in France have exceeded the designed value of the capacity factor and the actual power production and designed power production[7] are shown in Table 2.

Among the PWR nuclear stations in the world, Japan has the lowest cumulative capacity factor. As of 1979, it was only slightly greater than 50 percent. However, in 1980 and 1981 the capacity of the nuclear power stations in Japan has exceeded 61 percent[8] and then expect to reach 70 percent in 1985 and maintain at that level.[9] Judging from the circumstances, this objective may be realized ahead of schedule.

Based on the following information, we believe that the capacity factor used in the economic analysis of 900,000 kW to 1 million kW PWR stations should be taken as 70 percent.

According to composite data contained in Japan's atomic energy handbook, the cumulative capacity of HWR stations in Canada and Argentina is approaching 70 percent, in India it is less than 50 percent, and in Pakistan the figure is less than 40 percent. Anticipating the development in the next decade, we believe the capacity factor for HWR stations should be taken as 75 percent.

Table 2. Power Production of French PWR Stations

Reactor Name		Net Power (MW)	Date of Commercial Operation	Months of Commercial Operation	Power Produced as of 1 April 1982 (in billion kwH)	
					Actual	Design
Fessenheim	No 1	890	30 Dec 1977	48	21.2	18.9
"	No 2	890	18 Mar 1978	45	21.0	18.0
Bugey	No 2	920	19 Feb 1979	34	13.3	13.0
"	No 3	920	12 Feb 1979	34	13.4	13.0
"	No 4	900	17 Jun 1979	30	13.0	11.4
"	No 5	900	3 Jan 1979	23	10.9	8.5
Gravelines	No 1	920	1 Dec 1980	13	5.5	4.5
Dampierre	No 1	900	10 Sep 1980	15	5.8	5.2
Tricastin	No 1	920	1 Dec 1980	13	6.6	4.5
"	No 2	920	1 Dec 1980	13	6.5	4.5
Gravelines	No 2	920	1 Dec 1980	13	6.5	4.5
Dampierre	No 2	900	16 Feb 1981	9	4.9	3.3
Gravelines	No 3	920	1 Jun 1981	6	3.1	2.0
Dampierre	No 3	900	27 May 1981	6	3.2	2.0
Tricastin	No 3	920	11 May 1981	7	3.5	2.4
"	No 4	920	1 Nov 1981	2	1.3	0.7
Le Blayais	No 1	920	1 Dec 1981	1	0.4	0.3
Gravelines	No 4	920	1 Oct 1981	3	1.7	1.0
Dampierre	No 4	920	20 Nov 1981	1	0.5	0.3

III. Economic Comparison Standard of Power Plants

In foreign countries, a number of standard methods exist in the economic evaluation of investment projects, these are the recovery period method, the average recovery rate method, the net current value method, the intermediate recovery rate method and the project method. Such methods are described in detail in engineering economics and financial management textbooks, and will not be discussed here.

Comrade Xu Shoubo [1776 1108 3134] pointed out in the "Introduction to Technology Economics" that, in the evaluation of the economic effects of investments in technological projects, the most general approach is to compare the social labor consumption and the natural resources consumption. He gave the most general formula for such comparison and showed that the comparison formulae used in such method as the recover period are actually special cases of the general formula. He also made in depth discussion of the economic evaluation of energy projects in his book entitled "Energy Technology Economics."[10]
In order to use this general formula, we need some standard coefficients such as the capital utilization efficiency, the labor utilization efficiency, the resource consumption efficiency and the resource utilization efficiency. In the study of China's energy project economics, the most important factor is the capital utilization efficiency.

Since there are numerous methods in technology economic evaluation and in the determination of the standard coefficients, they should be unified by the government in a socialist country. In the Soviet Union, such standards are first proposed by the State Planning Council, the State Construction Council and the Academy of Sciences, approved by the cabinet and then used by the whole country. In China there have been no official comparison standards to use since the late 1950's. In February 1982, the then Ministry of Electric Power (now the Ministry of Water Resources and Electric Power) issued a tentative economic analysis formula for electrical power which contained the comparison standards. Before any state issued official standard becomes available, it is the only authoritative comparison standard today. In our economic analysis of the PWR and HWR power stations, we shall use the standards in this tentative regulation. The regulation stipulated that the comparison may be based on the minimum annual cost method or the internal recovery rate method, both are special cases of the general formula forwarded by Xu. We believe that the minimum annual cost method is closest to the customary analysis method used in China. The tentative regulation of 1982 described the minimum annual cost methods as follows: Let NF be the costs for the n years from m+1 to m+n, then after comparison, the proposal with the least NF is the one to adopt.

$$NF=Z\left[\frac{r_0(1+r_0)^n}{(1+r_0)^n)-1)}\right]+U$$

where Z is the total investment as of the mth year.

$$Z=\sum_{t=1}^{t=m} Z_t(1+r_0)^{m-t}$$

$$u=\frac{r_0(1+r_0)^n}{(1+r_0)^n-1}\left[\sum_{t=t'}^{t=m} u_t(1+r_0)^{m-t}+\sum_{t=m+1}^{t=m+n} u_t \quad \frac{1}{(1+r_0)^{t-m}}\right]$$

Here u is the annual operating cost, m is the number of construction years, n is the economic lifetime of the project (25 years for nuclear power stations), t is the number of years since the beginning of the construction, t' is the year that the project is put into production, r_0 is the investment recovery rate for the power industry or the capital utilization efficiency mentioned above. The 1982 regulation recommended a recovery rate of 0.1, which we shall use. The derivation of the formula is not complicated, but will not be given here because it falls in the realm of the basic principles of technology economics and can be found in the general literature. What should be emphasized is that in the economic comparison of technical proposals, if the proposals are equivalent in satisfying the needs and meeting the time requirements, the factors to consider are the investment and the production cost. In comparing two proposals, we should adopt the one with the lowest capital investment and the lower production cost. In such cases the conclusion can be arrived without using the formula of computation. The formula is needed only when a proposal has a higher capital investment but a lower production cost.

IV. Calculation Method and Results

The method used in this article for computing the power production cost is the same method used for conventional power plants, only the maintenance cost calculation is somewhat simplified. Compared with methods used abroad, the main differences are that we ignore the investment interest and inflation, that is, we completely ignore the time value of the capital utilization, and that we do not recognize the effects of price escalation. This method is obviously not sensible but we shall make no modification because it is consistent with the method of computation used nationwide in China. The conventional method for computing the power production cost includes nine items and the operator salary and material cost are computed separately. At present we do not have sufficient data to compute the secondary items, but because the two major items (capital construction cost and fuel cost) account for 88 percent of the production cost, we lumped the other seven items into a single maintenance cost which accounts for 12 percent of the total cost. The loss of heavy water in HWR stations is figured separately.

The basic formula for capital construction is

$$\text{Capital construction cost} = \frac{100\ (a + b)\ K}{8760\ L}$$

where 8760 is the number of hours in one year, the product 8760L is the amount of electricity (in kWh) produced by each kW of power in one year, K is the specific investment, a is the depreciation recovery rate (a is about 0.033 in a 30-year linear depreciation scheme), b is the major overhaul capital percentage and a + b = 0.05. Thus (a + b) K is the operating recovery cost in one year due to capital construction and overhaul for each kilowatt of capacity. Dividing (a + b) K by 8760L gives the capital construction cost, in units of yuan. Since the power production cost is usually expressed in fen, we multiply the result by 100 to convert into fen.

The fuel cost is computed as follows:

$$\text{fuel cost} + \frac{100C}{24\,\eta\,Z}$$

where C is the fuel price in terms of yuan per kilogram of uranium, Z is the average fuel consumption in units of kW (thermal power).day/kilogram of uranium, η is the net thermal efficiency of the power station, and the factor 24 changes days into hours for the convenience of computing kilowatt hours.

As stated earlier, the maintenance is 12 percent of the total cost. This is an approximate estimate but the error is not large because it is only a small portion of the total cost. In the power production cost computation of HWR stations, the loss of the heavy water during operation must also be taken into account. We assume that the loss of heavy water is 1.3 kg/hour for a 1 million kW HWR station, which translates to 0.08 fen/kWh of production cost.

Table 3 shows the calculation results. Based on the conventional calculation method used in China for power production cost and the initial parameters we used, the cost for one kilowatt hour of electricity in the early 1990's will be 3.23 fen for a one million kilowatt scale PWR station and 3.25 fen for a

HWR station. The cost for the PWR is about 1 percent lower. Considering the computation error, we take the power production costs of the two types of reactors to be the same. Since the specific investment of a HWR is 1.25 times of that for a PWR, the conclusion can be reached without resorting to the formula in the 1982 regulation. The conclusion is that PWR stations are more economical.

Table 3. Power Production Costs of 1 Million Kilowatt Size PWR and HWR Power Stations (in fen/kWh)

	PWR station	HWR station
Capital cost	1.180	1.400
Fuel cost	1.661	1.383
Loss of heavy water	0	0.080
Maintenance cost	0.387	0.391
Total	3.328	3.254

The above conclusion was drawn from a comparison of the power stations themselves. It is not enough in an economical analysis of nuclear power stations to consider only the reactors, a composite comparison must be made incorporating the nuclear fuel cycle system that goes with the nuclear power station. In the general analysis, a comparison should be made after an optimization analysis for the nuclear industrial systems associated with the two types of reactors in accordance with the state's nuclear power development plan. We assume that in the decade from 1991 to 2000, China will build a 1 million kilowatt nuclear power station per year. On this basis, we obtained the amount of fuel and heavy water needed per year and then conducted the optimization calculation using the mathematical model of (Bielinji) for nuclear fuel industry dynamic planning. We have described this model in detail in Ref. 11 and will not repeat it here. It should be pointed out that the economic data of China's nuclear fuel industry contain considerable error and the error in some major predictions may be as high as 10 to 20 percent or more. Since the total investment of the nuclear power industry will be of the order of 20 billion yuan, 10 to 20 percent of error has a great effect. Besides, reliable results in the optimization analysis can only be obtained when errors in the original data are taken into account. The Bielinji model has obvious shortcomings in error treatment. Such deficiency stems from the fundamental assumption that the profitability for a longer or shorter construction time obeys a Gaussian distribution. Experience shows that in most countries this distribution is asymmetric. The probability for a prolonged construction is much greater than that for completion ahead of schedule. Therefore, even though Bielinji et al used computers in their error treatment and optimization analysis, their results are still unreliable. We believe that in the optimization analysis using the Biejinji model, errors should be handled using the usual Monte Carlo theory to be more realistic. To this end Yang Xianshu [2799 0341 1659] and the author have written the computer software for optimization analysis using the Monte Carlo method in dealing with the errors. Preliminary results have been obtained.

Optimization analyses of the two nuclear industry systems showed that, to satisfy the needs of building one 1,000,000 kW nuclear power station per year beginning in 1991, the investment for the PWR nuclear fuel system will be only a few hundred million yuan more than the HWR system, but the building cost of a 10 million kW HWR station is several billion yuan higher than that of a PWR station of the same power. The savings on fuel cycle of a HWR system fall far short from compensating the higher construction cost. The same conclusion is reached even with the production costs of the nuclear fuel and the heavy water taken into consideration.

China's resources do not allow the simultaneous development of two different nuclear industrial systems, and there is no reason for doing so. Since the PWR system is more economical than the HWR system, we should concentrate our efforts in the development of PWR system and not divide our force by fighting on two fronts.

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SITE SELECTION FOR QINSHAN NUCLEAR POWER PLANT

Beijing HE KEXUE YU GONGCHENG [CHINESE JOURNAL OF NUCLEAR SCIENCE AND ENGINEERING] in Chinese Vol 4 No 1, Mar 84 pp 16-23

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[Text] This paper briefly describes site selection for the Qinshan Nuclear Power Plant--the first 300 MW PWR in China. The geography, geology, seismology, hydrology, transportation, power grid, and environment of the site chosen for the Qinshan Power Plant are described and evaluated and the major reasons for the site selection are indicated. The general layout of the Qinshan Power Plant is also briefly described.

I. Introduction

Site selection is an important stage in the construction of a nuclear power plant. It has a major effect on the safety, practicality and economics of the nuclear power plant, and therefore becomes an issue of great concern to the planning, design, construction and review organizations, as well as to the people. This work also involves a variety of areas such as geology, seismology, meteorology, hydrology, environmental protection, earth moving and construction, transportation, power plant technology, electric grid, overall layout, and society. It is a comprehensive and complex subject.

The Qinshan Nuclear Power Plant is the first 300 MW pressured water reactor [PWR] nuclear power plant designed, developed and constructed in China based on the policy of "self-reliance." There was a lack of experience in site selection, but it was done with support from various areas.

II. Overview of the Plant Site

2.1 Geographic Location

The Qinshan Nuclear Power Plant is located at the foot of Qinshan Mountain, which is 11 km southwest of Haiyan County in Zhejiang Province. The plant site is 92 km from Hangzhou and 126 km from Shanghai by highway. The highway

between Shanghai and Hangzhou (the Huhang Highway) passes the plant site approximately 2 km to the west (see Figure 1).

2.2 Topography and Geomorphology

The northeast side of the site faces Hangzhou Bay and the south side abuts Qinshan Mountain. The main peak of Qinshan is 185.8m high. Fangjiashan Mountain is to the west of Qinshan. North of Qinshan and Fangjiashan Mountain is a beach. The geomorphology and topography of the site can be divided into the following three categories:

1. Eroded and denunded hills, usually with a slope of 30° - 40°.

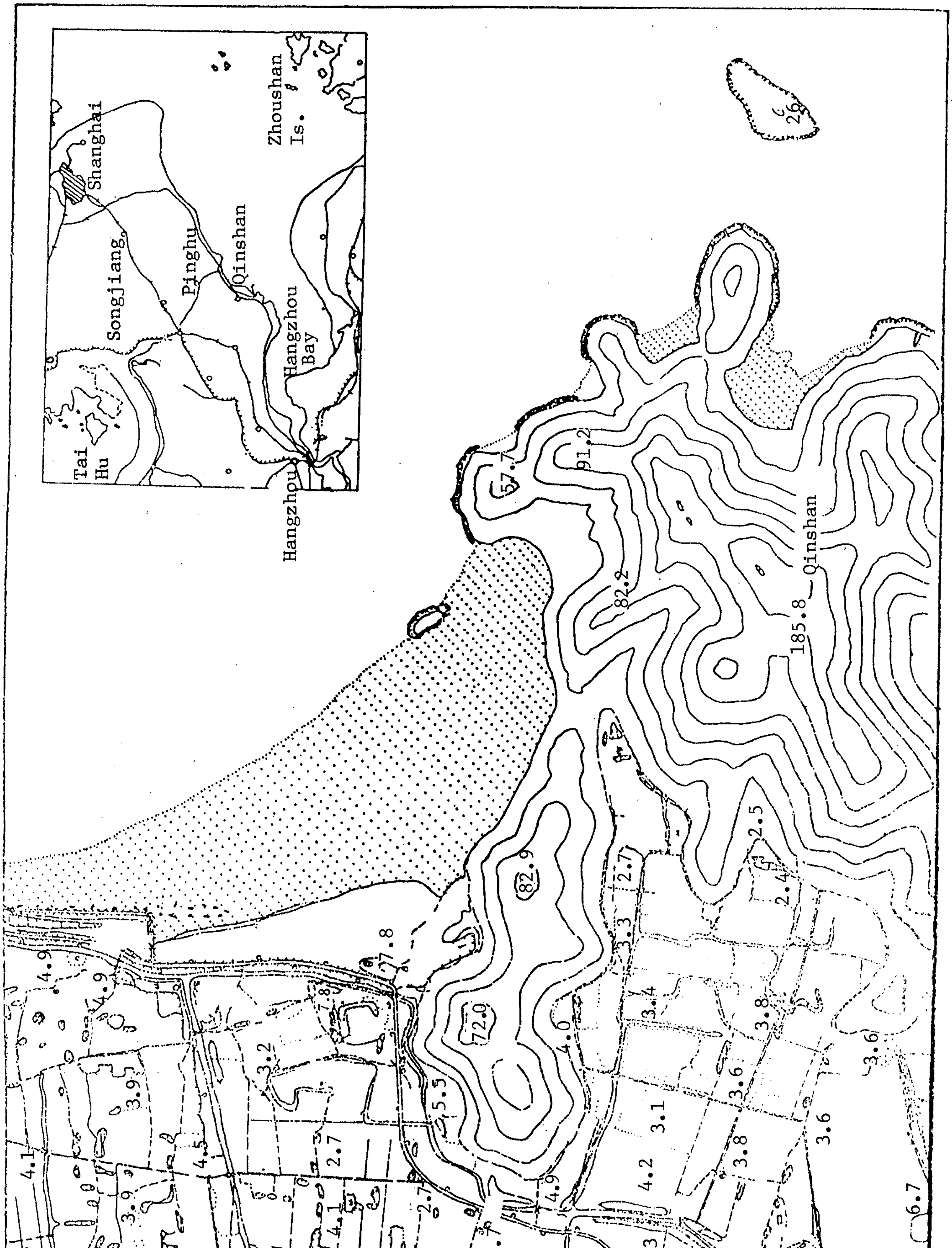
2. The valley is U-shaped and consists of an accumulation belt running northwest to the beach. Composed of slope clays and rock, the lower end has been turned into farmland. The elevation of the present-day land surface in the valley is 5-15m. The useful land area of 100 x 250m can be used for the main building of the power plant.

3. The beach has a natural elevation of 0-2.5m and slopes toward Hangzhou Bay. At low tide the beach area is approximately 800,000m^2. Southwest of Qinshan and Fangjiashan Mountains is Xiajia Bay. The valley is 700m long, 300m wide at the opening, 200m wide in the middle, and an average of 100m wide at the far end. The useful area is 100,000m^2. There are over 40 farm families in the valley and 80 mu of farmland.

2.3 Geology and Seismology

1. Geology

a. Geological History of the Region. In a 300 km area around the site, i.e., 27°40' - 33°20' N, 117°00' - 123°00' E, the tectonic units are part of two first-order structural units, the Xiayangzi paraplatform and the Nanhua paraplatform. Originally the region consisted of ancient metamorphic basement rock. In the last stage of the Proterozoic era, the Jiangshan-Shaoxing fault was created by the Xuefeng orogeny. From the beginning of the Ordovician period to the end of the Silurian period, the Caledonian movement gradually caused the Paleozoic subsidence belt in the northwest to rise and become dry land, the Cathaysian series of faults, running northeast between Xiaoshan-Qinchuan and Lian-Majin developed. In the Devonian and early Cretaceous, the region gradually rose and the land area continued to enlarge. In the late Triassic period, the major sign of the Indosinian movement was intense horizontal compression in the northwest-southeast direction, causing folding and uplifting of the Paleozoic and earlier strata, thus forming the major structural skeleton consisting of a large synclinorium in western Zhejiang and a large anticlionorium in eastern Zhejiang. The primary effect of the Yanshan movement was basement fracturing caused by the violent differential vertical movement, accompanied by numerous powerful and extensive magma intrusions and crevasse eruptions. At the end of the Tertiary period, the major feature of the Xishan movement was that some areas continued the subsidence that had occurred during the Yanshan movement, with pronounced block


Tai Hu
Shanghai
Songjiang
Pinghu
Qinshan
Hangzhou Bay
Hangzhou
Zhoushan Is.
Qinshan
185.8
82.2
91.2
57.7
82.9
72.0
7.8
7.8
4.0
5.5
4.9
2.7
3.7
2.7
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3.2
3.9
2.7
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26

movement but little folding. Basaltic lava flows developed and there was vigorous east-west tectonic movement. Since the Pleistocene era, there has been pronounced differential vertical movement along the fault: in the early and middle period the region tilted from the southwest toward the northeast, but since the Holocene era, the neotectonic movement has been characterized by a sinking motion with an average annual change less than 1mm. Thus, the geology in the region is basically stable.

b. Geological Structure of the Region. This region is located in the southern section of the second uplift of the Neocathaysian series in the Asian-Pacific region. It is between the huge Qinling and Nanling east-to-west tectonic belts. The portion in the East China Sea is located in the first subsidence belt. The structural system includes the Cathaysian series, Neocathaysian series, a east-west tectonic series, a north-west tectonic series, a south-north tectonic series, an E-shaped structure, and a twisting structure.

The direction of the Cathaysian structural layout is northeast (50°-60°); it is a relatively ancient structural system in the region. The major fault closest to the plant is the Qiuchuan-Xiaoshan fault, which has shown some reactivation in recent years, as has the Jiangshan-Shaoxing fault. There is no record of a destructive earthquake anywhere along the fault. The two major faults mentioned above are more than 10 km away from the site. The Neocathaysian system was created by a series of northeast faults and other associated structures. Among them, the fault east of Maoshan Mountain (the Piaoyang earthquake was the result of its activity) is approximately 170 km from the site. The Northwest tectonic belt is more developed and extensive, although the scale is not as large as the Cathaysian and Neocathaysian systems and the continuity is not as good. The Tongxiang-Haining fault, which is relatively close to the site, is limited to the Tongxiang depression. On the northeast and southwest sides of this fault the thickness of the Quaternary deposits varies only slightly. There is no sign of any recent activity.

2. Siesmology

a. Earthquake History and Severity in the Region. The northwest portion of this region belongs to the Yangzhou-Tongling belt in the middle and lower Changjiang seismic subregion. The middle section belongs to the Shanghai-Shangrao seismic belt. The southern section, bordered by the Jiangshan-Shaoxing fault, belongs to the northern part of the seismic subregion along the East China Sea Coast. Between 225 and 1979, there were 214 earthquakes of magnitude 3 or greater. In the nearly 1,000 years since 999, there have been 41 destructive earthquakes ($Ms \geq 4\text{-}3/4$) in the region within 300 km of plant site. The magnitude 4-3/4 earthquake of 26 May 1678 at Haiyan caused "roofing tiles to fall down." The severity of the earthquake may have been V-VII. No other quakes caused any destruction. As for very strong earthquakes outside the region, the magnitude 8-1/2 earthquake between Juxian-Yancheng in Shandong on 25 July 1668 had some effect on the plant site. This earthquake caused some damage in the Hangjia Lake region. The severity of this earthquake at the plant site was VI. According to an analysis of past seismologic data with 50 km of the site, earthquakes

of magnitude Ms ≥ 3 have occurred in the Hangjia Lake region and in Hangzhou Bay. Recently, on 5 November 1977, an earthquake of magnitude 3 took place at Cixi; it could not be felt at the plant site. Statistics indicate that the strain accumulated over the next 100 years in this seismic belt will be equivalent to the energy of an earthquake of magnitude of 7. However, the probability of a single release is extremely low. The section most likely to have a large earthquake is in the Yellow Sea and near the Maoshan tectonic belt! In the vast area north of the Jiangshan-Shaoxing fault, there has never been a strong quake of Ms ≥ 6. The number of Ms $\geq$ 4-3/4 quakes is also small and the highest magnitude is 5. These earthquakes were scattered around the Chang Jiang Delta east of Fuyang and in the ocean outside the mouth of the Chang Jiang. Based on intensity and frequency, the seismic activity level is low. The maximum probable earthquake severity in the next 100 years is only VI. According to the seismological and geological background of the region, the characteristics of seismic activities, and a comprehensive analysis of the trend of seismic activities over the next 100 years, the severity of the effect of probable earthquakes originating in various seismic regions and belts will be less than VI, based on the attenuation value given in the East China macroscopic earthquake effects chart. Although there is a possibility that an earthquake of magnitude of 4-3/4 to 5 may occur in the plant region, the severity will be only VI. The Seismology Bureau of Jiangsu has certified that the basic earthquake severity level is VI in the project area.

b. Safe-Reactor-Shutdown and Operating-Standard Earthquakes. The power plant is located in a low seismic severity zone. All major buildings are situated on rock. A severity of VII was adopted for the safe reactor shutdown level, I level higher than the basic severity of the site area. The horizontal acceleration at the surface is 0.10g at VII. In the design, 0.15g was used as a conservative figure. A basic earthquake severity of VII was used as the operating standard. A surface acceleration value of 0.075g was chosen for safety.

3. Engineering Geology

a. Lithology. The elevation of the top of the bedrock on which the main plant is to be built on is from 30 to -15m, and the slope is approximately 18 percent. Lithologically it is dacitic-liparitic brecciated crystalline-vitric tuff, with a compressive strength above 1000 kg/cm^2. The beach is mostly silty clay with a load-bearing capacity of about 8 t/m^2.

b. Stability of the Site. Qinshan Mountain is stable. The scale of faults found on site is usually small. The dip angles of the faults are relatively steep. They are mostly filled and cemented by veins.

4. Hydrogeology

The hydrogeology is very simple. The bedrock consists of blocks of magmatic rock. The water permeability is poor and the water content is small. The water table at the beach is high and widely distributed. The amount of surface emergence is small. The seawater is weakly corrosive.

2.4 Climate

The region belongs to the subtropical monsoon climatic zone. There are many clear cold days in the winter. Low pressure front activity is frequent in the spring, with abundant rainfall. There are always strong, variable winds along the coast. In the summer the southeast monsoon is at its height. With the exception of localized thunderstorms in the afternoon, the weather is characterized by clear and hot days with little rain. From June to September, there are frequent typhoon-related storms. The autumn weather is overcast and rainy, becoming more stable in October. According to the data gathered at a nearby meteorological station, the mean annual temperature is 15.8°C. The low is -10.8°C and the high is 38.1°C. The prevailing wind direction is southeast. The maximum wind speed is 32.2 m/s.

2.5 Hydrology

1. Ocean Hydrology. The water in Hangzhou Bay has the dominant effect. There are irregular semi-diurnal shallow tides. The speed of the rising tide is about 4 m/s and that of the falling tide is about 3 m/s. Hangzhou Bay is a partially enclosed sea area with obvious rivermouth characteristics, i.e. it is affected by the discharge of the Qiantang Jiang. The average chlorine content is 6.46 g/kg and the multiyear average water temperature is 18.1°C.

2. Land Hydrology. The plant site is located in the Taihu basin on the Hangjia Hu plain. A network of rivers connect with the Taihu, the Grand Canal from Beijing to Hangzhou, and the Huangpu Jiang. Ten kilometers away is the Changshan He, the project's fresh water supply. The riverbed is 65 m wide and the river is connected to a network of other rivers. When all gates are open, the maximum flow is approximately 290 m^3/s. Under normal conditions, water is abundant.

The circulating cooling water is taken from Hangzhou Bay. The bank at the site is stable. The main stream and deep channel are near the shore. The water intake distance is short. The drainage can be discharged into Hangzhou Bay through a sewer system. Because the flow rate is high, the tidal difference is large, and the tide itself is high, the warm water that is discharged can be diffused very well.

2.6 Transportation

1. Nuclear Fuel Transportation Plan. A combined waterway and highway plan will be used. The Minhang Shanghai Electric Motor Plant pier will be used for large equipment. The equipment will be hoisted from the pier to the barge by a floating crane and shipped from the Huangpu Jiang into the Zhangjianghe to the inner river pier of the Shanghai Petrochemical Corporation. A 600t crane will be used to hoist the equipment onto a 300t flatbed truck, which will move it from Jinshanwei to the power plant area via Zhapu.

2.7 Power Supply System

Approximately 40 km northwest of the plant is the Nanhu substation. The 200 KV lines from Shanghai's western suburbs and the Jinshan second loop are fed

into this substation. They are connected to the power grid at the Zhejiang Hangzhou substation by a 220 KV line. After the Qinshan Nuclear Power Plant is operational, power will be fed into the East China Grid through two 220 KV lines.

2.8 Effect of Power Plant on the Environment

There is no large or medium-size industrial or mining enterprise near Qinshan in Haiyan County, and therefore there is no source of harmful gases. The highway is approximately 2 km from the plant and the safety of the power plant will not be affected by traffic accidents. The airport is more than 40 km away from the site. There is no civil aviation route over the plant site; thus the threat to the power plant by civilian aircraft can be discounted. The primary natural condition affecting the safety of the power plant is the tide. In order to eliminate this threat, seawalls designed to resist high tide levels and wind and wave intensities encountered once every 100 years. The design should be reviewed with reference to the conditions of tides encountered once in 1,000 years plus wind strengths encountered once in 100 years.

2.9 Evaluation of Impact of Power Plant on Surrounding Population. The population distribution and population density within a radius of 50 km around the Qinshan site are shown in Table 1 (1980).

Table 1.

Distance (km)	Total population	Population density (person/km^2)
0-0.5	0	0
0-1	287	91
0-2	2,816	224
0-5	18,725	238
0-10	85,994	274
0-15	182,381	258
0-20	319,335	254
0-30	870,827	308
0-40	2,070,611	418
0-50	3,924,003	500

The population is basically distributed in eight sectors between the north-northeast and southwest. Compared to other regions in the Huadong area, the plant site has a small population density, especially within 20 km.

During normal operation, the effect of the power plant on the environment is evaluated in terms of "extreme rated operating conditions," i.e., assuming that the power plant is operating under the condition that the fuel rod cladding failure rate reaches 0.5 percent and the steam generator is leaking at at a rate of 3.17 l/hr.

When operating under this extreme condition, the radioactivity concentration at the discharge point is 2.2×10^{-11} Ci/l after the wastewater is diluted by 72,000 m^3/h of circulating water. According to the method recommended in

the U.S. Standard "Radioactive Material in Main Liquid Effluent of a Light Water Reactor Power Plant," ANSI 18.1/N-237, the radioactivity discharged to the environment by this project is less than 3.65 Ci/yr, which is lower than the design standard of 5 Ci/yr recommended in Appendix 1 of 10CFR50. Because the tidal drop in Hangzhou bay is large and the average tidal flow is 270,000 m^3/s, we can be sure that the concentration of the effluent is equivalent to the natural background not far from the outlet.

Similarly, the rates of release of various major nuclides can be calculated from the assumed extreme rated operating conditions. If the restricted area of the power plant is a 500-meter circle centered on the reactor, it is possible to calculate that the total equivalent radiation dose for an individual at the boundary of the restricted area is 0.37 mrem/yr through annihilation radiation, ingestion, inhalation and ground residues. The thyroid dose equivalent is 6.65 mrem/yr. These values are far less than the values of 50 and 1,000 mrem/yr respectively permitted by China's "Radiation Protection Regulations."

To evaluate the effect of accidents on the environment, the release of 2 percent of the total iodine and inert gases from the reactor core to the safety containment as a result of failure of both ends of the main pipe in the primary loop is used as a base according to Guideline 4.2 and Appendix 1 of the U.S. Nuclear Regulatory Commission. Based on this calculation, the individual doses received within 2 hours of the accident at the border of the plant site (500 m from the reactor) are shown in Table 2.

Table 2.

Safety container leakage (1/d)	Whole-body β annihilation dose (rem)	Whole-body γ annihilation dose (rem)	Thyroid dose from radioactive iodine (rem)
0.1 percent	1.05×10^{-3}	2.32×10^{-3}	1.32×10^{-1}
0.3 percent	3.14×10^{-3}	6.93×10^{-3}	3.97×10^{-1}

The individual doses received during the entire accident period (30 days) on the border of the plant premises are shown in Table 3.

Table 3.

Safety container leakage (1/d)	Whole-body β annihilation dose (rem)	Whole-body γ annihilation dose (rem)	Thyroid dose from radioactive iodine (rem)
0.1 percent	4.32×10^{-3}	5.99×10^{-3}	1.16
0.3 percent	1.29×10^{-2}	1.80×10^{-2}	3.47

All of these figures meet U.S. specifications ANSI 18.2a and 10CFR100, "Reactor Site Guideline" (total dose 25 rem, thyroid dose 300 rem). In addition, if the plant site is evaluated according to the extreme assumption that 25 percent of the equilibrium iodine in the reactor core and 100 percent of the inert gas are released externally during a core meltdown when both ends of the main pipe in the primary loop break, in accordance with Guideline 1.4 of the U.S. Nuclear Regulatory Commission, then the doses received by an individual 2 hours after the accident at the border of the plant site, shown in Table 4, still meet the 10CFR100 specification.

Table 4.

Safety container leakage (1/d)	Whole-body β annihilation dose (rem)	Whole-body γ annihilation dose (rem)	Thyroid dose from radioactive iodine (rem)
0.1 percent	0.5	1.1	36.2
0.3 percent	1.5	3.3	122

III. Overall Layout

3.1 Scale of Construction

The plant area of the project consists of the following seven parts.

1. Core Component. This primarily includes the reactor building, primary loop auxiliary systems building, fuel storage building, main control tower, steam turbine generator building and chemical water treatment building.

2. Waste Treatment Component. This mainly consists of the solidification building, waste storage building, special motor vehicle garage and special laundry room.

3. Water Supply and Drainage Component. This mainly includes the circulating pump room, water purification treatment room, fresh water intake pump room (outside the plant area), fire extinguishing pump station and rain pump room.

4. Power Supply Component. This mainly consists of the refrigeration station, compressed air station, gas supply station and backup heat supply station.

5. Repair Component. This mainly includes the machine shop, electrical repair shop and instrument repair shop.

6. Warehouse Component. This primarily consists of the general warehouse and equipment and materials warehouse.

7. Front Office Component. It mainly consists of the production administration office building, environmental monitoring station, cafeteria and reception hall. The total area of the construction is approximately 100,000 m^2.

3.2 Overall Layout

The design plan for the overall layout began with site selection. After comparing many plans, the reactor core was located in the middle of the U-shaped gully. The seashore area will be expanded by landfill within the seawalls. The main plants for the core component will be situated on bedrock after the mountain is excavated and earthwork is done on the slopes. The steam turbine generator plant and the circulating water pump room will be placed on the side near the water supply from Hangzhou Bay. The waste treatment component, power supply component, repair component, warehouse component and front office component will be placed on the seashore in a sequence based on their relation to the core area. The construction and expansion sites will also be placed there.

The amount of excavation in the core area is approximately 800,000 m^3, of which 600,000 m^3 is rock.

IV. Overall Evaluation

Geologically, the Qinshan Nuclear Power Plant Site is basically stable. The basic earthquake severity is low. Geological surveys for the project turned up no unfavorable geological conditions. All the main plants can be placed on bedrock. The major plants are next to the mountain, which serves as a shield for the residents nearby. The environmental protection conditions are very good. Water can be taken from Hangzhou Bay for cooling. The dilution conditions for the discharge of warm water and minutely radioactive wastewater are good. The station is located in the East China Grid. The power transmission line is short and simple. Transportation by water and highway is convenient. Summarizing the above points, one can see that the choice of this site is suitable in terms of safety, suitability and economics for a nuclear power plant project. These are the fundamental reasons for the site selection of the Qinshan Nuclear Power Plant.

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LI PENG SPEECH KICKS OFF 6TH ANNUAL CONSERVATION MONTH

HK090841 Beijing JINGJI RIBAO in Chinese 1 Nov 84 p 1

[Article by Li Peng [2621 7720], vice premier of the State Council: "Focus on Energy Conservation in the Course of Economic Reform"]

[Text] Note: Today is the first day of the Sixth National Energy Conservation Month Drive. Vice Premier Li Peng has especially written this article for this paper. [end note]

The Sixth National Energy Conservation Month Drive is about to be launched. Through the efforts of various quarters, fairly good achievements have been attained in energy conservation work in the past year. Not only have the advanced enterprises in energy conservation, which were chosen last year, made new progress, even more advanced enterprises and trades in energy conservation have emerged. For example, the Taicang chemical fertilizer plant in Jiangsu has continuously maintained the advanced national level for total energy consumption per ton produced of ammonia; the Shenyang No 4 rubber plant has reduced its total energy consumption in spite of a big increase in its output value and, in the metallurgical industry, thanks to the methods of assessment, rewards, and punishment on energy consumption per ton of steel produced, the overall energy consumption per ton of steel produced in key enterprises has continuously dropped. The departments and trades which have done relatively well in energy conservation also include the power industry, light industry, oil refineries, and small nitrogenous fertilizer plants. The provinces and municipalities which have done fairly well in energy conservation include Shanghai, Liaoning, Zhejiang, Jiangsu, Anhui, and Hunan. According to statistics from relevant departments, the energy saved throughout the country from January to September this year amounted to the equivalent of some 15 million tons of standard coal. It is estimated that the annual energy conservation plan for the equivalent of 18 million tons of standard coal can be fulfilled this year.

It should be noted that in the past year our energy conservation work has begun to shift from strengthened management and waste reduction to technological transformation in energy conservation and that a number of energy conservation projects have gone into production and have produced results. The basic work on energy conservation has been strengthened and considerable progress has been made in the installation of "three meters" (water meters, electric meters, and gas meters) in 15 cities and in the implementation of energy consumption plans in more than 100 key enterprises.

Some comrades ask: Now that the situation in energy production is excellent, why is it still necessary to make great efforts to grasp energy conservation? It should be affirmed that since the beginning of this year a rarely seen excellent situation has emerged in energy production. We have overfulfilled the production plans for coal, petroleum, and power in the first 3 quarters, with growth ranging from 7 to 9 percent. It should be noted, however, that with the development of industrial and agricultural production and the improvement in the people's living standards, our energy production still fails to meet our needs. Energy production is still a conspicuously weak link in the national economy. According to estimate of relevant departments, most provinces and municipalities will meet with varying degrees of difficulty in energy supply next year, both in coal and in electric power. For this reason, we should not relax our efforts simply because we have attained some successes in energy conservation. On the contrary, we should be more conscious about the pressing need for energy conservation and regard this as a long-term task for the entire economic front and the whole society.

The longer we engage in energy conservation work, the more difficult it will probably become and the more work we shall probably have to put in. We should keep on grasping energy conservation in the future. First, it is necessary to pay close attention to the reform of this work. The 3d Plenary Session of the 12th CPC Central Committee has made a decision on carrying out an all-round reform of the economic structure. We should also promote the in-depth development of energy conservation work with the spirit of reform in order to attain more practical results. The key to the reform lies in the application of not only the administrative methods but also, to a great extent, the economic means to arouse the initiative of energy users, to promote energy conservation, and to ensure the work by legal means. In recent years, in an effort to solve the problem of every enterprise eating from the "same big pot" in energy consumption, many units have carried out effective reforms. We should sum up their experiences and popularize them. Second, further efforts should be made to grasp technological transformation in energy conservation. If our principal achievement in energy conservation in the past few years has been attained by relying on reduction of obvious waste owing to management problems, we should, therefore, while continuously strengthening management, rely more on technological progress. As is known to all, the energy utilization ratio in our country is very low. According to some statistics, energy consumption for the production of every 10,000 U.S. dollars worth of GNP is 26.8 tons in China, 8 tons in the United States, and 3.5 tons in Japan. An important cause for this lies in the backwardness of China's industrial equipment and technology. For this reason, it is necessary to implement the state regulations on energy conservation, to discard obsolete high energy consumption equipment, to reform the backward technology, and to vigorously popularize and apply energy-saving new techniques, new technologies, and new products. A few industries, such as the metallurgical industry, chemical industry, power industry, and textile industry, have started to apply computers in production control. They have attained marked results in reducing energy consumption and have also blazed a new trail for energy conservation work in the future. Moreover, publicity and various other basic work on energy conservation are still important. We should continue to pay close attention to them and to do a good job of them.

We believe that as long as the governments at all levels and the various departments and trades strengthen leadership over this work, define the focal point of their energy conservation work in light of the specific conditions in their own localities and units, and take some practical actions for energy conservation, and so long as the whole nation makes a concerted effort, we will certainly be able to score greater successes in the sixth national energy conservation month drive and in future energy conservation work.

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EFFORT TO SAVE BY POWER INDUSTRY COULD REAP MAJOR BENEFITS

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[Article by Li Huasheng [2621 5478 3932] of the Ministry of Water Resources and Electric Power: "Energy Conservation in China's Power Industry"]

[Text] Energy conservation is a long-term strategy in China's four modernizations construction. The electric power industry is an important component of the energy industry. In 1982 China's power industry consumed 130 million tons of raw coal--20 percent of the total coal production--and 18 million tons of oil--60 percent of the total oil consumption. Electric power is becoming an increasingly greater portion of the primary energy source: in 1970 it was 20.72 percent, in 1975 it was 21.48 percent, in 1982 it had reached 23 percent, and by the year 2000 it is expected to be 20-30 percent. Conservation in the power industry therefore has a major impact on the overall national conservation effort because the power industry not only consumes a great amount of energy but also has great potential for more conservation. Compared to advanced industrial nations, the energy consumption by China's power industry is higher by about 33 percent. If the correct conservation policy is adhered to and effective conservation measures are taken, it is conceivable that 100 million tons of coal can be saved by the year 2000. The benefits of conservation in the power industry are great and genuine attention must be given to it in China's overall conservation effort.

Conservation in the power industry may be divided into two large categories. One type of conservation is the result of developments and advances in the power industry, technical advances in all professions have increased the consumption of electrical power and the conservation benefits are society-wide. The other type of conservation is the result of technical, economical and managerial measures taken by the power industry itself. The direction of conservation in the entire power industry should be in these two areas.

I. Macroscopic and Overall Conservation in the Power Industry

(1) Speeding up the electrification process and increasing the percentage of electric power in energy consumption are effective conservation measures

and are important indirect components in the macroscopic society-wide conservation effort.

A secondary energy source, electricity can be easily and conveniently converted into light, heat, and dynamic energy at a high efficiency and is a form of high-grade energy. The higher the percentage of primary energy consumption by the electric power industry, the higher the utilization efficiency of the entire energy sources and the lower the energy consumption. This is because the wide utilization of electric power can effectively improve the mechanization and automation processes of industry and agriculture so that the labor force and productivity are further improved, as well as work conditions. It also helps to improve product quality and save material and fuel. There is no other form of energy in the world that has as wide an application as electric power and as great an effect on the development of an industrial society.

According to an analysis of 84 countries and regions with a per capita gross value of production greater than $400, the countries with a higher percentage of electric power in their energy consumption have a lower energy consumption per dollar of gross value of production. Countries with 30 percent of electric power in energy consumption consume an equivalent of 0.88-1.5 kg of standard coal for 1 dollar of production value. Countries with only 17.5 percent of electric power in their energy consumption consume as much as 3.5 kg per dollar of gross value of production. The difference is 2-4 fold. This shows that the total efficiency of energy consumption depends on the mode of the final energy consumption and especially on the percentage of the electric power. The efficiency of equipment in production and daily life can be greatly improved by using electric power.

The reality in China's power industry today is that the development of electric power does not suit development of the national economy. According to a recent survey, 10 million kilowatts of facilities in China are short 40 billion kilowatt-hours of electric power based on their production force and the value of production in industry and agriculture is affected by more than 20 percent. The value of production is 0.065 yuan/kWh, and the capital investment is 0.3-0.5 yuan/kWh, but the industrial value of production is 2-3 yuan/kWh and each kilowatt-hour brings in 0.5-0.8 yuan of income. These figures show that the development of the power industry is good for the national economy and that the economic benefits are immense. Blackouts cause great loss in industry. Based on the survey statistics of blackout losses suffered by industries and enterprises in Beijing, the loss is 20-30 times the production cost of electric power. The statistical data in the Soviet Union also show that blackout loss is about 30 times the production cost. Therefore, the development of the power industry promotes the national economy, accelerates the electrification process, and is an important means to ensure the continued progress of the various departments in the national economy and, in an indirect way, saves energy.

(2) Developed power grids allow the rational use of energy resources and compensation and modulation between hydropower and thermal power. Developing

potential in the various power grids and making economic adjustments are conservation measures that benefit the entire power industry.

The distribution of resources in China is not uniform, the locations of energy resources do not coincide with the centers of power consumption. Hydroelectric resources are mostly in the southwest, the western part of the central-south region, and the central part of the northwest. Coal resources are concentrated in Shanxi, Nei Mongol, Shaanxi, Ningxia, and Guizhou. Northeast and eastern China and the Beijing-Tianjin region in the economically developed coastal area account for 70 percent of the national total industrial and agricultural value of production and 70 percent of the national total electric power consumption. These regions have a serious energy shortage. The geographic locations, together with difficulties in transportation, dictate the basic arrangement of delivering electric power produced in the west to the east. In order to make rational and sufficient use of energy resources, we must develop the power grids.

The development of power grids will lead to a conservation of energy because of the following reasons:

1. The power grids connect the resource-rich regions with the energy-short regions and effectively solve the supply problem.

2. The power grids will allow small hydropower facilities to make use of unique advantages and reduce the amount of water wasted.

It will also improve the energy utilization rate and make better use of thermal power plants and fully exploit the potential of power production facilities.

3. The power grids will compensate and adjust the benefits of the hydropower stations in different river vallies and make full use of the hydroelectric resources.

4. The power grids will make use of differences in time and season and separate demand peaks in power usage. The grids can back each other up and reduce the amount of surplus power. These two benefits will show up as reduced generator capacity, improved equipment utilization, more efficient energy usage, lower capital investment and conservation.

5. The power grids will help the economic adjustment, improve the utilization efficiency, reduce the losses in the grids and conserve more energy.

II. Conservation in the Power Industry Itself

(1) Develop high-temperature, high-pressure, high-efficiency, and large-capacity thermal poer generators

The fraction of thermal power is now, and will remain to be, more than three-fourths of the total power production. The development of high-temperature, high-pressure, efficient, large-capacity generators is an

important conservation effort in the electric power industry and it is also an important technological policy of the power industry. It has been proved effective in improving the energy utilization rate, conserving energy, shortening the construction time, upgrading the productivity and accelerating the pace of development.

In 1982 the coal consumption for power production in China was 400 grams of standard coal per kilowatt-hour (434 g/kWh for supplying electricity) which exceeded the consumption in advanced countries by 100 g/kWh. The potential for conservation is therefore great. By the year 2000 the efficiency of thermal power plants could be raised from the present 28.3 percent to 35-37 percent and the consumption could be lowered to 335-345 g/kWh. When this is accomplished, the power industry will save 90-110 million tons of coal per year. This is a major technological goal for the power industry.

The 300 MW and 600 MW generators based on imported technology should be developed as soon as possible and put into batch production. The current 200 MW and 300 MW generator should be improved to achieve better efficiency, reliability and versatility. To meet the needs of peak regulation in the power grids, large-capacity variable-pressure generators should be developed. The steam pressure of this type of generators should be developed. The steam pressure of this type of generator changes according to the load but the steam temperature basically remains unchanged. The advantages are an improved thermal efficiency at low load, a faster start-up, a faster response to the load and a prolonged service of pressure-bearing components.

(2) Build thermal power plants in favorable locations to utilize resources more efficiently and to conserve energy resources

The total capacity of China's generators for heating purpose is about 5 million kilowatts which accounts for 10 percent of the total thermal power capacity and conserves 5-6 million tons of raw coal. On the whole, the conservation effects are good.

An important conservation method is to centralize the heat supply and combine the production of heat and electric power. This would not only improve the energy utilization rate but also reduce the pollution of the environment and improve the quality of life. It should be actively promoted. In addition to the heating plant, other modes of centralized heating include centralized heating stations, high-efficiency steam or hot water boilers and heating with residual heat from industrial production processes.

The advantage of combining the production of heat and electricity is that it replaces the numerous small-capacity industrial boilers and heating furnaces. The efficiency of industrial boilers is low, generally only 55 percent and in some cases 70 percent, but the boiler efficiency of heating plants can be as high as 90 percent. The combined power and heating plants will not only provide heat and electric power, the energy utilization rate can be as high as 50-60 percent. With separate production of heat and electric power, the energy utilization rate is only about 30 percent.

Besides, obsolete industrial boilers are very ineffective in dust removal and seriously pollute the environment. The heating and power plant boilers, on the other hand, make use of advanced burning technique and equipment and are much more effective in dust removal. They will greatly improve the urban environment.

The technological and economic policies in developing the heating and power plants are:

1. An overall plan for heat supply should be formulated according to economic development and specific local situations. The optimum plan should be selected based on technological and economic arguments and then a task plan should be made to determine the modification or construction mode and the implementation steps.

2. The problems of industrial supply of heat should be solved first, especially the heat supply for the chemical, refinery and textile industries. The economic benefits of a combined power and heating supply is most prominent in industries with a heating load of 4,000-5,000 hours per year.

3. The most appropriate mode of heating supply for civilian buildings in cities should be determined on the basis of climate, city planning, speed of construction, environmental protection, heating load density and growth rate, and the pipe network structure.

The potential of local thermal power plants should be exploited to broaden the scope of heat supply. Measures should be taken to improve the heat utilization of existing thermal power plants to meet the needs of increased demand of heat.

4. The crucial steps that determine the economic benefits of the heating plants are the selection of the generator and to increase its utilization hours.

5. The planning of the heating network and the feasibility study of the construction projects must be done well. An overall plan should be made for the thermal power plants, heating plants and new users of heat.

6. Operational management must be strengthened.

7. The government should support the combined production of heat and electric power by giving it special considerations in material allocation, interest and terms of loan, taxes and pricing.

Technological improvements should be made to upgrade the existing 13 million kilowatts of low- and intermediate-pressure condensation type units that consume 20 million tons more raw coal than they should.

Today, China has 13 million kilowatts of low- and intermediate-pressure condensing type units that make up 26 percent of the national total thermal power capacity. Most of these units have operated more than 20 years, some

of them are 50-60 years old and the machines and the technology have become obsolete. They have a low thermal efficiency and consume large quantities of coal. The average coal consumption is 500 grams of standard coal per kilowatt-hour of electric energy and the thermal efficiency is only 22 percent. Some of the smaller units consume as much as 1000 g/kWh. These units create a serious urban pollution problem and release great amounts of dust, sulphur dioxide, and ash every day. It is therefore very important that systematic technological improvements be made to upgrade the existing low- and intermediate-pressure condensing units while high-efficiency, large-capacity new units are being developed.

Improvements of the low- and intermediate-pressure condensing units should be carried out in a planned and systematic manner. In-depth technological and economic analysis and feasibility study should be made on the basis of the specific conditions of the units and the situation of the power grids they are in. Improvement plans should be formulated accordingly and the plans should be implemented in a phased and staggered manner.

The criteria for improving the low- and intermediate-pressure units are:

1. Replacing the existing low and intermediate pressure units with high efficiency and large capacity units.

2. Changing low and intermediate pressure condensing units into heating units.

3. Adding pre-turbine units.

4. Reducing the operating time of these units as power generating units and using them as peak regulating units in the power plant or as spare units for maintenance or incidence in the power grid. Some of the units may be used as phase modulation units in the summer and operated at a low vacuum in the winter using circulating water for heating.

5. Low and intermediate pressure units in remote regions are still the workhorses in the power plants and they will in principle be left alone and not modified for the time being. In regions inaccessible to the power grids but having a local reserve of coal, small and intermediate power plants should be built systematically according to the local situation. Low- and intermediate- pressure units making use of the residual heat and originally intended for heating purposes will in principle remain the same and may even be further developed where appropriate.

(3) The business and technical management standards of existing power grids and power plants should be improved and the technologies should be upgraded to conserve energy.

The most distinct feature of power production is that the generation, transmission and utilization of electric power are accomplished simultaneously. The three phases of production, supply and usage constitute

a complete system and conservation in the power industry must therefore be approached while taking the three phases as a whole. This requires a major effort in improving the management of existing power grids and power plants.

First, we must make the eneterprise leadership and all the workers aware of the importance, urgency, and long-term nature of the conservation task. Conservation should be made a crucial task in business management. A capable and knowledgeable conservation management team should be established to promote the entire conservation effort. An overall energy resource balance system should be set up to strengthen energy accounting in power plants and other important energy facilities. An equipment maintenance system should be set up to ensure the safe and economic operation of the equipment. Low-efficiency, poor-performance auxiliary machines such as blowers and water pumps should be improved and where possible replaced by more efficient equipment.

For hydropower plants, in addition to sound and efficient operation of the equipment, the reservoir and water should be used economically and rationally. Efforts should be made to forecast the water information accurately (especially the forecast of high-water seasons and floods) so that waste is low and efficiency high. The practice of producing an excessive amount of hydropower to solve shortage problems should be strictly avoided. The water level in long-term regulation reservoirs should not be allowed to drop to the bottom level except in particularly dry years. In annual regulation reservoirs the water level should not be allowed to drop too fast in the early stage in order to avoid shortages later on.

The hydraulic structures and generating equipments should be improved. Reservoirs are often prevented from achieving the designed water level because of defective hydraulic structures or geological problems of the dam foundation. Accumulation at the tail water of hydropower stations often reduces the power generation waterhead and increases the water consumption. Defective generation equipments not only affect the output and efficiency but also lower the usefulness of the units in the power grid. Incompatible transmission and generation capacity can prevent the electric power from being sent out efficiently.

The economic management of the power grids should be improved and equal-increment coal consumption management should be implemented in thermal power plants. High-efficiency thermal power units and heating units should first be operated at base load to increase the utilization hours and low-efficiency units may be used as modulation units. Hydropower stations should be running at full load during the flood season to meet the base load and thermal power units should be used for peak modulation and as space units so that the water resources may be fully utilized and fuel can be saved. In the low-water season, thermal units should assume the base load and hydropower used as spare units and for peak modulation. Hydropower and thermal power should be deployed, managed, and accounted for in a unified manner and an award system for water and coal conservation should be set up to achieve the maximum conservation benefits of the entire power system.

The management of the transmission equipment in the power grids should also be improved to reduce loss. Today, China loses 30 billion kilowatt-hours of electric energy per year in transmission (a loss rate of 8.5 percent), so cutting transmission losses is an important task in conservation. The power grid loss depends on a number of factors such as the power grid structure, the technological level, the current distribution, the voltage, and the power factor. The power grid loss not only reflects the management level but is also constrained by the design and construction of the grids. The following approaches should be taken to reduce the loss: 1) Improve the existing low-voltage power grids, extend the high voltage circuits into the load centers, simplify the voltage classification and reduce redundancy; 2) Improve the operating voltage of the grids, make use of the voltage transforming capabilities of the generators and properly choose the transformer shunts; 3) Install reactive compensation equipments to improve the power factor; and 4) For existing overloaded transmission lines, replace the conductors, add double wires, or install secondary loops to reduce the loss in the network.

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